DOCUMENT RESUME

ED 028 092 56 SE 006 499

By-Poulos, Chris G.
The Relative Effectiveness of a Closed-Circuit Television Team-Teaching Method in High School Biology Instruction. Final Report.
Wausau Senior High School, Wis.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No-BR-5-0720
Note-104p.
EDRS Price MF-$0.50 HC-$5.30
Descriptors-Academic Achievement, *Biology, *Closed Circuit Television, *Instruction, *Secondary School Science, *Team Teaching, Television
Identifiers-Cooperative Biology Test, Metropolitan Science Test, STEP Science Test

Studied was the achievement of ability-grouped students enrolled in sections of the biology course at Wausau Senior High School in the years 1963-64 and 1964-65. The biology students in the 1963-64 school year were taught by a team-teacher approach which included large-group presentations. During the second year, the students enrolled in biology were taught through the team approach except that televised teacher presentations were substituted for large-group presentations. Tests were administered pre- (STEP Test, Form 2B, Science and The Metropolitan Science Test), mid- (unit exams in botany, zoology, physiology, and genetics), and post- (investigator constructed exam and Cooperative Biology Test, Form X) experiment. Concluded were that (1) students instructed in large groups earned significantly higher scores on the botany unit test, the Cooperative Biology Test, and the Wausau Final Test than did the students receiving television presentations, (2) students instructed through television presentations earned significantly higher scores on the genetics-unit test than did students instructed in large groups, and (3) all mean differences for the biology achievement tests existed in the same direction for both high ability and average ability students. Student attitudes were favorable to both modes of instruction. (RS)

ED 028092

BR 5-0720
PA-56
OE-BR

THE RELATIVE EFFECTIVENESS OF A CLOSED-CIRCUIT TELEVISION TEAM-TEACHING METHOD IN HIGH SCHOOL BIOLOGY INSTRUCTION

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Project No. 84-H

Principal Investigator
Chris G. Poulos
Wausau Senior High School
Wausau, Wisconsin

Report Written by

Calvin Gale
University of Wisconsin
Madison, Wisconsin

Chris G. Poulos
Delavan-Darien High School
Delavan, Wisconsin

The research reported herein was performed pursuant to a grant with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

SE 006 499

ACKNOWLEDGEMENTS

Milton O. Pella
Professor of Science Education
University of Wisconsin
Madison, Wisconsin

The Biology Instructional Team
of Wausau Senior High School

Carol Augspurger

Richard L. Dix

Allan E. Hughes

Judith Rogness Kickland

William A. Smiley

Janet Volk

Nancy Hess, Secretary

Chris G. Poulos, Team Leader

TABLE OF CONTENTS

Page

LIST OF TABLES iv

CHAPTER

One — Nature of the Study 1

Two — Origin & Development of the Team . . . 5

Three — Related Research 17

Four — Design of the Study 22

Five — Results of the Statistical Analysis . 32

Six — Summary and Conclusions 43

BIBLIOGRAPHY 51

APPENDICIES 54

LIST OF TABLES

Page

TABLE 1 Treatment Groups and Frequencies 28

TABLE 2 Summary of the Analysis of Variance for the Henmon-Nelson Test 33

TABLE 3 Summary of the Analysis of Variance for the Nelson Silent Reading Test 34

TABLE 4 Summary of the Analysis of Variance for the Metropolitan Science Test 34

TABLE 5 Summary of the Analysis of Variance for the STEP Test (Science) form 2B . . . 35

TABLE 6 Summary of the Analysis of Variance for the Botany Test 35

TABLE 7 Summary of the Analysis of Variance for the Zoology Test 36

TABLE 8 Summary of the Analysis of Variance for the Physiology Test 36

TABLE 9 Summary of the Analysis of Variance for the Genetics Test 37

TABLE 10 Summary of the Analysis of Variance for the Cooperative Biology Test 37

TABLE 11 Summary of the Analysis of Variance for the Wausau Biology Final Test 38

TABLE 12 Summary of the Tests of Significance for the Achievement Tests 40

APPENDICIES

Page

APPENDIX A Summary of Analysis of Covariance for the Botany, Zoology, Physiology, Cooperative Biology and Wausau Final Test 54

APPENDIX B Opinionaire Completed By All Biology Students of This Study and Tabulated Responses 60

APPENDIX C Wausau Constructed Biology Achievement Tests Used in This Study 65

APPENDIX D Calendar of Biology Presentations Made During the Period of This Study and Teacher and Student Daily Schedules 96

CHAPTER ONE

Nature of the Study

During the four years 1959-63, the staff of the biology department of the Senior High School of Wausau, Wisconsin, conducted an experimental program concerned with the instructional methods and procedures in tenth grade biology. The program included utilization of certified professional personnel, the addition of non-certified secretarial personnel, class schedule reorganization and an increase in the use of learning equipment, primarily in the form of audio-visual aids. The data collected as a result of this experiment were analyzed by Robert W. White (34).* A subsequent report of the experimentation conducted at Wausau was published in 1963 by Milton O. Pella and Chris G. Poulos (21).

In the team teaching project at Wausau, five biology teachers cooperatively formulated a curriculum and made decisions concerning methods of instruction to be used in large and small group sessions. Each team member developed those subject areas in which he had special interest and competency. The final curriculum was a result of the interactions between the members of the team as they coordinated their individual areas into a total course supported by a highly coordinated audio-visual program based upon accepted methods of presentation. Although statistical analysis of biology achievement test scores indicated no significant differences between a team-taught-group of 220 students and a traditionally-taught-group of an equal number of students, the less objective gains must not be ignored: i.e., all teachers involved agreed that participation in the team activity resulted in: (1) improved teaching effectiveness even when teaching traditional classes, (2) an increase in the depth and breadth of subject coverage, (3) more interesting and stimulating class presentations, and (4) a more challenging course for the student.

---

* Studies cited are listed beginning on page 51.

It seems from the data collected that the team teaching procedures used in Wausau, Wisconsin, were just as effective in teaching subject matter in tenth grade biology as the traditional teaching methods. However, certain problems were noted:

> (1) Due to the normal turn-over of staff members, some team members were replaced by new teachers. It was felt that this tended to decrease the effectiveness of the team because the new staff members were generally unfamiliar with inductive teaching procedures and with preparing highly coordinated audio-visual presentations. Two basic problems were to find some way to extend the effectiveness of the experienced, master teachers who formed the nucleus

of the team and to integrate new teachers into the team.

(2) A secondary problem concerned the scheduling of 220 biology students into two large group sessions each week. Due to the problems of limited plant facilities and staff assignments, it was necessary to restrict the modified schedule of the biology team to a two-period block of time. It was also necessary to fix the time periods of the large group and small group sessions in order that they might dovetail with other short week courses so that students could program a full schedule. This inflexibility led to problems in operating proper laboratory classes, in instructing students who missed presentations through absence, and in resolving program conflicts of some students. The question arising at this point was whether or not some method could be developed by which presentations could be recorded by the master teachers and played in various classrooms at any given time thus eliminating the need for large group sessions but maintaining the techniques and procedures which had been developed and found to be effective.

Televised presentations seemed to offer hope for the solution of the schedule and student program problems. Thus it was decided that the large group presentations would be replaced by televised presentations which could be recorded and replayed to small groups. The televised presentations were evaluated during the 1964-65 school year.

Problem

To determine whether any significant differences exist in the subject matter achievement of two groups of students enrolled in high school biology when one group is taught utilizing the teacher team approach in large group sessions and small group sessions and the other group is taught in a teacher team approach utilizing closed-circuit television in place of large group sessions.

CHAPTER TWO

The Origin and Development of the Team

In Making Teaching and Learning Better, John Guy Fowlkes writes,

> "On December 13, 1958, a group of City School Superintendents from Wisconsin communities joined with representatives of the School of Education -- The University of Wisconsin in discussing the need for improvement in the curricula offered by the University toward certification for teaching, and teaching in local school systems.
>
> . . . it was the unanimous judgement of the group that a concerted effort toward improvement in the preparation of teachers on the University campus, as well as in learning and teaching in the local school systems, was demanded. It was further agreed that a long-existing, intimate working relationship between the University and the local school systems represented should be formalized under the title: The Wisconsin Improvement Program -- Teacher Education and Local School Systems.
>
> The State Superintendent of Public Instruction gave his full endorsement to the program.
>
> Application was made to the Ford Foundation for subsidy toward the initiation and partial support of the Improvement Program. During the formulation of firm plans to serve as the basis for the application, the writer on January 1, 1959, was relieved of all duties other than those attendant on the establishment of the Improvement Program. On April 1, 1959, the Ford Foundation announced a grant of $625,000 to the University of Wisconsin to make possible the activation of the Improvement Program.
>
> After no little discussion both on and off campus, the following eight school systems became participating partners with the School of Education -- The University of Wisconsin on the thesis of exploring and experimenting

> with ways and means of providing a better educational offering for prospective teachers, cooperative in-service training for experienced teachers, and conditions for more effective learning by boys and girls: Hales Corners, Janesville, LaCrosse, Madison, Manitowoc, Racine, Wausau, and West Bend." (11)

During the summer of 1959, the Wisconsin Improvement Program instituted the first of a series of summer seminars at which teachers representing the eight school systems named above were brought together and exposed to the resources of the university through its library, through contact with its faculty members, and through contact with various researchers throughout the country that were attempting in some way to improve instruction in the classroom or improve the training of teachers.

One teacher from the Wausau District Public Schools, spurred by the writings of J. Lloyd Trump in Images of the Future (33) and Alexander Stoddard in Schools of Tomorrow (29), as well as the writings of other investigators in the field of educational research, became interested in the possibility of establishing a team teaching program at the Wausau Senior High School. It was from this program that the Biology Instructional Team Project at the Wausau Senior High School was developed.

At that time a few high schools in the United States were experimenting with team teaching. Notable among these was the work being done at Bay City, Michigan; Wayland, Massachusetts; Snyder, Texas; and Jefferson County, Colorado.

These schools were studying the areas of teacher aides, large class instruction, schedule modification, or some aspect of team teaching. A review of the literature describing various experimental programs failed to reveal any objective statistical analysis of their programs. Some of the general characteristics of their studies were helpful in considering a plan for the Wausau Project. In discussion with several members of the School of Education of the University of Wisconsin a plan was devised to set up the framework upon which a program of team teaching in Wausau was to be developed. It was decided that the experimental program, if it were to be effective, should be of at least three years duration. One year would be required to make plans, accumulate necessary equipment, and attempt to solve any other problems which may arise in the planning discussions. The program would be put into practice in the classroom during the second year in order to determine if it was practicable. Provided that the second year could be shown to operate with a reasonable amount of success, a third year would be included in which a thorough evaluation of the project would be conducted.

Organization of the Team

It was decided that the team project would be in the area of biology because of the academic preparation of the teachers involved. In order to facilitate the organization and functioning of the project, the following subcommittees were formed:

1. A research committee whose twofold function was to determine what previous related research existed and whether this would have any effect on the proposed project.

2. A curriculum committee whose function was to re-evaluate the biology curriculum and prepare an outline of the subject matter to be presented, including a detailed plan of how it was to be presented. The curriculum committee was also responsible for developing a working schedule for the teachers and students in the schedule modification phase of the project.

3. An evaluation committee whose function was to determine how to evaluate the project and the student subject mastery, including the development of testing instruments if standard tests were deemed inadequate.

4. A budget committee whose function was to determine what equipment and supplies would be necessary to implement, adequately and effectively, the work of the curriculum committee and to prepare a budget.

At the end of the first year the committees had the following report:

The primary objective of the biology project at Wausau is to improve instruction. Secondly, recognizing that the teacher population is not increasing proportionately to the student population and that the economic feasibility of providing more classrooms and teachers under present traditional methods is open to question, it may be possible to instruct greater numbers of students without a proportionate increase in classrooms and teachers by utilizing team teaching.

The Biology Team Teaching Project of Wausau is based primarily on the following two points:

1. Staff utilization - which involves the scheduling of a group of teachers to permit team planning and instruction in order to gain a more effective and efficient use of each teacher's academic interests and preparation.

2. Schedule modification - which involves adjusting teacher and student class schedules seeking to develop more efficient programming schedules which permit more time for realistic, effective preparation and decrease unnecessary repetition in presenting subject matter.

The research committee spent several days in the library of the University of Wisconsin checking sources of information pertinent to the project. They returned with helpful information concerning methods of large group presentations, some of which were incorporated into the project. They were unable to find evidence of any other project that had developed a team teaching approach identical to that being considered by the Wausau group.

The curriculum committee reported as follows:

Members of the curriculum committee divided the biology course into six units for the purpose of outlining what material was to be presented to the students.

At weekly meetings the committee incorporated individual outlines into one overall curriculum outline. The outline was then divided into an appropriate number of presentations for the year. These presentations were then fitted into a working schedule. In preparing these outlines the committee tried to keep in mind that an attempt was being made to alter the emphasis of the course from one of traditional morphology to that of a physiological view. The committee members developed the outlines into almost script-like presentations that were to be made during the course of the year. The curriculum committee also established a class schedule for programming students into large group and small group sessions as follows:

Phase I 1960-61 and 1961-62

	M	T	W	T	F
1		Four	Control	Sections	
2		Individual		Preparation	Team Planning
3	Presentation (All Sec.)	Lab. Sec. A B C D	Presentation (All Sec.)	Lab. Sec. A B C D	Disc. Sec. A B C D
4	Individual Prep.		Critique & Staff Mtg.		Disc. Sec. A B C D
5		Four	Control	Sections	
6		Three	Control	Sections	

Phase II 1962-63

	M	T	W	T	F
1	L. S. Sec. I K L M	Individual Prep.	Life Science	Sections	I K L M
2	L. S. Sec. N O P R S X	Life Sci. Presentation	Life Science	Sections	N O P R S X
3	Biology Presentation	Biology Lab. Sec. A B C D	Biology Presentation	Biology Lab. Sec. E F G H	Bio. Disc. Sec. A – D
4	Team Prep.		Critique & Staff Mtg.		Bio. Disc. Sec. E – H
5	Individual	Preparation	Team Prep.	Individual	Preparation
6	L. S. Sec. T U W	Individual Prep.	Life Science	Sections	T U W

Programming of individual pupils was made possible by the administrative staff in cooperation with the members of the teaching team. Attempts were made to dovetail the program of each pupil in the biology research group with physical education, driver's education and/or study halls. The committee planned for the use of the overhead projector, a 16 mm. film projector, an automatic slide projector, and a film strip projector in the large group sessions. The curriculum committee also evaluated thirteen biology textbooks as a part of its effort to choose the best textual material to become part of the biology curriculum. The committee members also determined which subject areas each of them felt most confident to present. A schedule was then prepared which allowed each teacher to make his contribution in his chosen area of interest and academic preparation. The committee expected to encounter difficulty in the operation of the project, but through careful organization, work, and inspiration they were able to overcome them.

The report of the evaluation committee was as follows: The evaluation committee agreed that unit examinations would be given approximately every eight weeks in an effort to determine student subject mastery. They recognized the lack of competent evaluation instruments. An attempt was made to develop some testing devices based upon the following three levels of mastery: reiteration, recognition of facts used in problem solving given the problem and its solution, and utilization of known facts involving previously unencountered problems.

The Proposal

The following proposal was submitted to the Wisconsin Improvement Program:

"The present method of instruction of biology at Wausau is divided at three separate levels. There are accelerated classes for the academically talented students, regular classes for the average student, and special classes for the slow-learner, slow-reader. We propose to divide these three classes into two separate groups in two phases. During the first phase, the first groups to be used as our control will be taught in the traditional manner. The second group will be instructed by a teacher team. The team leader or presentor will present the subject to all students in one large group session. He will utilize the special abilities and talents of the team members, various audio-visual instruction devices, such as films, filmstrips, overhead projectors, closed circuit television, etc., guest experts, and any other instructional method that the team can devise or utilize. The large group will then be divided into an appropriate number of small groups for the purpose of discovery and reinforcing the presented subject matter in a two-hour laboratory and a one-hour discussion, quiz section. This first phase is expected to last for two years. The first year, 1960-61, is to be an experience year for the team. The second year, 1961-62, is to be the evaluation of the research project during which time data will be gathered. In the second phase, which will be in the third year of the project, all students will be divided into two groups both of which will be taught by teacher teams. The first group will consist of all students of mid-average ability and up. The second group will be composed of those of mid-average ability and down. Group one will be taught an academic biology course which includes a phylogenetic study of organisms, human physiology, and cellular biology with emphasis on elementary cell chemistry, heredity, and embryology. Group two will be taught a life science course which will emphasize practical applications of biology based on an ecological, conservational, health approach to biological problems. There will be sufficient flexibility of programming in borderline cases to allow students to take the course deemed most beneficial in consideration of their individual interest and needs. Greater emphasis will be placed on inductive teaching methods in both courses stressing the understanding of biological concepts and principles."

Anticipated Benefits

Anticipated benefits of the project were stated as follows: "By utilizing the teacher team approach to instruction, the committee expects to gain more time for the individual teachers to prepare and thus be able to increase the proficiency and efficiency of teaching. In order to assist the teacher, an instructional secretary will be provided who will perform tasks such as grading objective tests, recording and averaging grades, typing, filing, processing audio-visual materials, and various other non-professional duties thus giving the teacher more time to concentrate on the professional task of teaching the individual students. By being able to better utilize the individual talents of the various teachers so that each teacher may present his strongest side to the students and thus have all of the students gain more from the overall strength of their teachers rather than from their individual weaknesses."

Team in Action

1. Administration of Team

An effective team operation is based upon the interaction of the individual team members. At the onset, the individual teachers were reluctant to criticize each other or to submit to evaluation by their colleagues. It was necessary for the team leader to provoke the teachers to perform some real soul-searching concerning their own attitudes, understandings, and techniques of science and science education. Eventually the team began to jell from a group of individuals to an actual team of teachers. The critiques thereafter defy description. They became dynamic sessions of self-evaluation, critical planning, and a source of creative teaching.

2. Presentations

At the close of the planning year (1959-60) the subcommittees were disbanded. The biology teachers then focused their attention on the actual operation of the team. Prior to presenting a given unit, the team members discussed objectives, methods, and techniques with the presentor. The presentor then planned the unit in detail including a specific subject matter outline, methods of presentation, audio-visual illustrations, laboratories, discussions, etc. Upon completion of this planning, the presentor and team leader discussed the unit in a final probing to improve upon the presentor's plans. Following the presentations a critique is held by the team to evaluate the presentations and offer constructive criticism.

3. Scheduling

Due to the schedule modification, the team members had twice the amount of preparation time as that allotted under traditional scheduling (see appendix D). This extra preparation time was found to be inadequate during the experience year prior to the development of a backlog of various materials -- especially audio-visual materials.

4. Instructional Secretary

An instructional secretary had been provided for the teacher team. Experience showed that the utilization of a secretary did not decrease a teacher's work load but rather permitted teachers to do a more effective job of planning, creating and developing instructional methods and materials.

CHAPTER THREE

Related Research

"There can no longer be any doubt that students learn efficiently from instructional television. The fact has been demonstrated now in hundreds of schools, by thousands of students, in every part of the United States and in several other countries. .....We now have approximately 400 scientifically designed and statistically treated comparisons of ITV and classroom teaching. .....Instructional television is at least as effective as ordinary classroom instruction, when the results are measured by the usual formal examinations, or by standardized tests made by testing bureaus.", states Wilbur Schramm, Director of the Institute for Communications Research in Educational Television -- The Next Ten Years (27).

Further information that can be obtained from Schramm's report includes the following: That in 65% of a very large number of comparisons, we can say with considerable confidence that between televised and classroom teaching there is no significant difference; in 21%, students learned significantly more; in 14%, they learned significantly less from television.

Schramm discusses a number of basic questions. Beyond the fundamental problems of learning and attitude, several questions are asked most frequently about instructional television. Among these are:

1. Is there any type of student that profits more than other types from instructional television? It may be that both the brightest and slowest students may derive some differential benefits from televised teaching -- the former because they learn rapidly anyway, and television can theoretically offer them a great number and variety of responses to learn; the latter, because television concentrates their attention as a classroom often does not, but it must be admitted that we do not yet understand the relation of mental ability to differential learning from television.

2. Does the size of the class make any difference in learning from instructional television? Students generally prefer to be in small rather than in large classes (White's (33) analysis of the Wausau Team Teaching Project does not bear this out), with no differential effect of class size or learning from ITV has been reported in cases where viewing

conditions are equally satisfactory. In one reported study, the size of television classes was varied between 19 and 120 students without producing differential results in learning (7).

3. Does televised teaching make any difference in retention of subject matter over a long period? One study of military training found that television-taught students remembered more of the subject matter one month later (16). Another military study (4) and five civilian studies (3) (6) (17) (20) (28) found no significant differences. In each instance mentioned above the analyses conducted were between televised procedures as contrasted to traditional or traditional-like classroom procedures. Apparently no study has been conducted of any combination of televised instruction with team teaching.

The evaluation of the Wausau Team Teaching Project as reported by White (34) and Pella and Poulos (21) indicates that there were no significant differences in achievement as measured by subject matter tests of two groups of students studying biology when one group is taught utilizing a team teaching approach and the other group is taught utilizing a one-teacher-per-class approach.

The evaluation of the Wausau team teaching program included an analysis of opinionnaires administered to students and teachers (34). Both students and teachers expressed a preference for the team teaching program. Students cited such team teaching advantages as the opportunity to get individual help and a more interesting course due to the variety of teachers and teaching techniques employed. Teachers cited such advantages as: (1) improved teaching effectiveness even when teaching groups of traditional size, (2) an increase in the breadth and depth of subject coverage, (3) more interesting and stimulating class presentations, and (4) a more challenging course for the student.

One may conclude from the above cited works that apparently most television-taught students either show a significant gain over non-television-taught students or achieve at as high a level as non-television-taught students. A similar statement may be made concerning team teaching methods as compared to non-team teaching methods in a variety of studies. However, no work as yet appears to have been done in attempting to combine these two areas to improve instruction. A question that immediately comes to mind is: Would the combination of television instruction with a team teaching method result in significantly greater learning than in team teaching instruction?

CHAPTER FOUR

Design of the Study

Design of the Study

During the 1964-65 school year instructional television was introduced into the Wausau biology team teaching program. This decision resulted from a desire to retain the instructional advantages of the large group presentations while introducing a greater flexibility into the class scheculing and student programming procedures.

Television Facilities

During the spring and summer of 1964, a small office and an adjoining storeroom were remodeled to provide the space for a television studio and control room. Additional lighting was provided by suspending a series of adjustable and movable spotlights from the ceiling.

Two vidicon, 400 line cameras were acquired. One camera, fitted with a monitor as a viewfinder, was mounted on a tripod and dolly and utilized as a floor camera. The second camera was suspended from the ceiling by means of a telescoping square, tubular rod attached to a length of track. Thus, although suspended from the ceiling, the second camera could be raised or lowered and moved from one end of the studio to another. In addition, this camera was supplied with a remotely controlled pan and tilt mechanism and a remotely controlled zoom lens. Both of these devices were controlled from the console in the control room.

Two lavalier microphones and an amplifier were the primary components of the audio system. The amplifier was built into the control room console along with a mixer module in order to blend the video and audio signals befdre they were fed into the video tape recorder. A series of small receivers allowed the control room operator to monitor the signals from the two cameras and the video tape recorder. A switching device, in the console, allowed the operator to select which of these signals would be transmitted along the coaxial cable to the classrooms.

Each of four biology classrooms was equipped with two 23 inch television receivers for student viewing. In addition, four small group viewing stations were wired into the auditorium. This was necessary in order to have all the pupils in eight biology sections view a live presentation simultaneously.

Some major problems that hampered the functioning of the televised presentations throughout the course of the year were (1) inability to acquire the video tape recorder until the start of the second semester and (2) the occurrence of technical difficulties which were frustrating to the team members who had little experience with television maintenance. During semester two of the project, an electricity-electronics instructor from the Industrial Arts Department of the school was added to the Biology Team Staff on a two-hours-per-day basis. Even this limited amount of time was very helpful.

In making the presentations, one staff member operated the console, another acted as a director, one student operated the floor camera, and another student assisted wherever necessary.

The "presentor" would prepare a detailed outline of subject matter to be covered together with camera cues. Copies were made for each person working in the studio. Filmstrips, slides, films and microprojections were shown by rear screen projection techniques with one or another of the cameras being cued in advance as to which "shot" would be next in order. Demonstrations, dissections, pictures, charts, models, etc. were some of the aids employed during the course of the presentations. Other techniques utilized "on camera" included interviews, discussions and lectures.

Despite the fact that the "presentor" and studio personnel usually had 28-30 man hours per week to prepare for the following week's two fifty-five minute presentations, lack of sufficient time was another handicap.

Problem

The decision to substitute televised presentations for the large groups presentations in the Wausau biology team teaching program led to this problem: To determine whether any significant differences exist in the subject matter achievement of two groups of students enrolled in high school biology when one group is taught utilizing the teacher team approach with large group presentations and associated small group discussions and laboratory sessions while the other group is taught utilizing the teacher team approach with televised presentations and associated small group discussions and laboratory sessions.

Test Instruments Used for Evaluation

Four unit examinations covering the units on botany, zoology, physiology and genetics were administered at intervals during each school year. Two final examinations, the Wausau Biology Final Test and the Cooperative Biology Test (Form X), were administered at the conclusion of each school year. The Wausau Biology Final Tests and the unit tests were constructed by the Wausau biology teachers and staff members of the Department of Education of the University of Wisconsin.*

Administered prior to the beginning of the school year were the Henmon-Nelson test of Mental Ability (Form B, 1958), the Nelson Silent Reading Test, the Cooperative STEP Test (Form 2B, Science) and the Metropolitan Science Test. A summary of these tests is shown in Table 2.

The reliability of the Wausau tests was determined by White (34). Applying the Kuder-Richardson formula (KR_{20}), he determined that the reliability coefficients ranged from 0.849 to 0.939. No reliability data are available for the

---

*Copies of these biology examinations may be found in Appendix C.

Cooperative Biology Test and the STEP Test. STEP Test is a determined reliability coefficient of 0.810. There is no reason to believe that the reliabilities of the two forms differ substantially.

TEST INSTRUMENTS USED IN THE
WAUSAU BIOLOGY TELEVISION PROJECT

	Test	No. of Items	Constructed by
1	Henmon-Nelson Test of Mental Ability	90	Houghton Mifflin Co.
2	Nelson Silent Reading Test	275	World Book Co.
3	Metropolitan Science Test	55	Harcourt Brace World Co.
4	STEP Test, Form 2B (Science)	60	Educational Testing Service
5	Unit Test in botany	75	Biology Staff, Wausau
6	Unit Test in zoology	75	Biology Staff, Wausau
7	Unit Test in physiology	75	Biology Staff, Wausau
8	Unit Test in genetics	70	Biology Staff, Wausau
9	Cooperative Biology Test, Form X	85	Educational Testing Service
10	Wausau final examination	75	Biology Staff, Wausau

Design

During the 1963-64 school year the students enrolled in biology at the Wausau Senior High School were taught utilizing a teacher team approach with large groups presentations and associated small group sessions. Prior to the beginning of the school year the Henmon-Nelson Test, the Cooperative STEP Test (Form 2B, Science), the Iowa Silent Reading Test and the Metropolitan Science Test were administered to all students. At intervals during the school year the four unit test, the Wausau biology final examination and the Cooperative Biology Exam were administered to all biology students.

During the 1964-65 school year the students enrolled in biology at the Wausau Senior High School were taught utilizing a teacher team approach with televised presentations and associated small group sessions. Testing procedures followed were the same as used during the 1963-64 school year.

The biology enrollment was grouped according to ability each year. Students having I.Q.'s above 120, high previous grades in science and high reading scores were placed in the high ability group. Students having I.Q.'s in the range of 105 to 120 were placed in the average ability group. Students with I.Q.'s below 105 were placed in a separate biology course designated as Life Science and are not a part of this study. Thus the four groups shown in Table 1 comprise the population of this study.

A 2 x 2 factorial design was used in this experiment.

Data are analyzed by analysis of variance and analysis of covariance procedures.

TABLE I

TREATMENT GROUPS AND FREQUENCIES

	1963-64 (No Television)	1964-65 Televised Presentations
High Ability	25	57
Average Ability	164	150

Analysis of the Test Data

Initially the achievement test data were analyzed by analysis of variance procedures. Means, variances and correlation matrices were obtained for each of the four group-year combinations. Estimated mean squares were computed for each test. These mean squares were then used to set up confidence intervals for the two comparisons of interest, achievement of the high ability groups over treatment and achievement of the average ability groups over treatment. The form of the confidence interval is as follows:

$$(\overline{X}_1 - \overline{X}_2) - \sqrt{F_{\alpha,1,392} \text{ (MSE) } \left(\frac{1}{M_1}+\frac{1}{M_2}\right)} \quad M - M \quad (\overline{X}_1 - \overline{X}_2) + \sqrt{F_{\alpha,1,392} \text{ (MSE) } \left(\frac{1}{M_1}+\frac{1}{M_2}\right)}$$

where $F_{.05,1,392} = 3.86$ and

$M_1 =$ no. of high ability students, no television

$M_2 =$ no. of high ability students, television

$m_1 =$ no. of average ability students, no television

$m_2 =$ no. of average ability students, television

The interactions for the analysis of variance were graphed for each test. These graphs suggested that the treatment groups differed prior to the experiment and thus an analysis of covariance was run to determine how much of the final differences of achievement test data could be attributed to the initial group differences. In the analysis of covariance the scores on STEP Test, Form 2B (Science) were used as covariants.

Among the assumptions for analysis of covariance are:

1) There should be a significant correlation between the dependent and independent variables.
2) The initial differences should be significant.
3) Slopes of regression lines should be the same.
4) Variances should be homogeneous.

A review of the analysis of variance correlations and the graphs indicated the Henmon-Nelson Test of Mental Ability and the STEP Test, Form 2B (Science) might be suitable as covariates, though neither showed highly significant initial differences. It was decided to perform an analysis of covariance on the Cooperative Biology Exam scores using the STEP Test alone as a covariate and again the STEP Test and the Henmon-Nelson-Nelson Test were used as covariates, comparing the results to determine whether the addition of the second covariate contributed very much to the analysis.

For an unequal frequency design of this sort, available computer programs have an upper limit of 100 replications 1 cell. Hence, there were two alternatives in the analysis:

1) Throw out a large number of observations to make the frequencies proportional to simplify computation on a calculator.
2) Split the groups and apply the computer program to the resulting "reduced" experiments.

The latter route was chosen and the average ability groups were randomly split into 2 parts. The high ability groups were not split due to the small cell frequencies which would result and, in any event, splitting both groups could only introduce additional sources of error into the analysis.

Using a table of random numbers and going down the data sheets for the subjects, the subject numbers were paired with the random numbers. If both were even or odd, the subject was labeled 2; if one number was even and one odd, the subject was labeled 1. The randomization was one for each section, most sections being split about evenly.

The above procedure was followed twice and an analysis of variance program was run to obtain some information about how well matched the split groups were. The two randomizations are referred to as yellow and blue (data punched on yellow and blue cards respectively).

The main interest was in how the group variances compared. Only the variances for the biology achievement tests are of interest, and on the basis of these results it was decided to employ the blue randomization for 1963-64 and the yellow randomization for 1964-65 in the covariance analyses. On the basis of the analyses of covariance of the Cooperative Biology Exam scores, the decision was made to use the STEP Test, Form 2B (Science) alone as covariate.

Opinionaire

In addition to the objective analysis of the test data, it was felt that the opinions and judgements of the students should be considered in any final evaluation of the application of televised presentations to the Biology Team Project. A questionnaire was constructed which would allow students to make a scaled response to certain pertinent questions concerning their opinions of the project. The frequencies of the responses were tabulated.* Due to the subjective nature of this form of evaluation no attempt was made to statistically analyze the data.

---

* The opinionnaire with the responses tabulated is shown in Appendix B.

CHAPTER FIVE

Results of the Statistical Analysis

This study was designed to determine whether significant differences exist in the subject matter achievement of two groups of high school biology students when one group is taught utilizing the teacher team approach with large group presentations and the other group is taught utilizing the teacher approach with televised teacher presentations.

The initial analyses of variance of test score data gathered with four tests administered prior to the teaching period and six tests administered during and following the teaching period are summarized by tests in Tables 3-12. In each cell the cell mean is the upper value while the lower value in parentheses is the mean square of the cell. The estimated mean square for each analysis is shown in parentheses below the grand mean in the lower right corner of each table. Below each table are the confidence intervals computed for each ability group. The following symbols are used in the confidence interval statements:

M_{A1} = mean of high ability group (large group presentations)

M_{A2} = mean of high ability group (televised presentations)

M_{B1} = mean of average ability group (large group presentations)

M_{B2} = mean of average ability group (televised presentations)

The analyses of the tests administered prior to the teaching period (Tables 3-6) show that the groups differed prior to the experiment. This suggested using the analysis of covariance to determine how much of the achievement test differences could be attributed to the differences existing prior to the experiment. No analysis of covariance was carried out on the genetics test data since those differences were already highly significant, and the analysis of covariance would only serve to increase these differences.

TABLE 2

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE HENMON-NELSON TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	121.9600 (33.4567)	118.6140 (33.7055)	119.6341
Average Ability	113.1770 (45.7784)	113.0070 (24.0067)	113.0958
Column Means	114.3388	114.5510	114.4497 (34.7381)

Confidence intervals - (95%)

$$.5682 < M_{A1} - M_{A2} < 6.1238$$
$$-1.1383 < M_{B1} - M_{B2} < 1.4783$$

TABLE 3

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE NELSON SILENT READING TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	11.9680 (.49810)	11.6860 (1.00516)	11.7720
Average Ability	10.7890 (1.99890)	10.9047 1.44595	10.8443 10.8443
Column Means	10.9450	11.1198	11.0364 (34.7381)

Confidence intervals - (95%)

$- .3057 < M_{A1} - M_{A2} < .8697$
$- .3952 < M_{B1} - M_{B2} < .1611$

TABLE 4

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE METROPOLITAN SCIENCE TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	11.7160 (.590567)	11.4526 (.791109)	11.5329
Average Ability	10.7427 (1.541480)	10.7707 (1.565850)	10.7561
Column Means	10.8714	10.9585	10.9169 (1.3853)

Confidence intervals - (95%)

$- .2913 < M_{A1} - M_{A1} < .8181$
$- .2893 < M_{B1} - M_{B2} < .2333$

TABLE 5

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE STEP TEST (Science) Form 2B

	Large Group Presentations	Televised Presentations	Row Means
High Ability	31.3211 (43.9767)	30.1404 (33.1585)	30.5000
Average Ability	27.5061 (27.5521)	26.4867 (27.7280)	27.0191
Column Means	28.0106	27.4928	27.7399 (29.4255)

Confidence Intervals - (95%)

$$-1.3770 < M_{A1} - M_{A2} < 3.7362$$
$$-.1847 < M_{B1} - M_{B2} < 2.2235$$

TABLE 6

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE BOTANY TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	60.3200 (35.3933)	55.8246 (48.0401)	57.1951
Average Ability	49.4939 (70.2638)	45.6067 (64.5758)	47.6370
Column Means	50.9259	48.4203	49.6162 (62.7920)

Confidence intervals - (95%)

$$.7608 < M_{A1} - M_{A2} < 8.2300$$
$$2.1283 < M_{B1} - M_{B2} < 5.6461$$

TABLE 7

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE ZOOLOGY TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	59.8400 (43.1400)	62.7895 (62.4192)	61.8903
Average Ability	50.7256 (68.5807)	49.8800 (72.0660)	50.3216
Column Means	51.9312	53.4348	52.7172 (67.4677)

Confidence intervals - (95%)

$$-6.8207 < M_{A1} - M_{A2} < .9217$$
$$-.9776 < M_{B1} - M_{B2} < 2.6688$$

TABLE 8

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE PHYSIOLOGY TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	56.3600 (51.4067)	57.8772 (61.8596	57.4146
Average Ability	47.4573 (72.5564)	45.9733 (58.8315)	46.7484
Column Means	48.6349	49.2512	48.9571 (64.5165)

Confidence intervals - (95%)

$$-5.3028 < M_{A1} - M_{A2} < 2.2684$$
$$-.2989 < M_{B1} - M_{B2} < 3.2669$$

TABLE 9

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE GENETICS TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	51.2400 (32.1067)	59.9123 (49.2243)	57.2683
Average Ability	43.8598 (65.3483)	50.0933 (60.0449)	46.8376
Column Means	44.8360	52.7971	48.9975 (58.9938)

Confidence intervals - (95%)

$$-12.2922 < M_{A1} - M_{A2} < -5.0524$$
$$-7.9384 < M_{B1} - M_{B2} < -4.5286$$

TABLE 10

SUMMARY OF THE ANALYSIS OF VARIANCE FOR THE COOPERATIVE BIOLOGY TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	56.2800 (75.7100)	47.1754 (72.8258)	49.9512
Average Ability	43.5732 (91.9271)	37.8733 (70.8228)	40.8503
Column Means	45.2540	40.4347	42.7348 (80.1837)

Confidence intervals - (95%)

$$4.8843 < M_{A1} - M_{A2} < 13.3249$$
$$3.7123 < M_{B1} - M_{B2} < 7.6875$$

TABLE 11

SUMMARY OF ANALYSIS OF VARIANCE FOR THE WAUSAU BIOLOGY FINAL TEST

	Large Group Presentations	Televised Presentations	Row Means
High Ability	51.0400 (45.3733)	46.9474 (46.9793)	48.1951
Average Ability	40.9146 (59.2074)	38.5133 (46.0233)	39.7675
Column Means	42.2539	40.8357	41.5126 (51.6022

Confidence intervals - (95%)

$$.7071 < M_{A1} - M_{A2} < 7.4781$$
$$.8068 < M_{B1} - M_{B2} < 3.9958$$

The randomization procedures described in Chapter Four followed by the analysis of covariance yielded the summary tables for each randomization under test shown in Appendix A. More informative are the confidence intervals which can be compared with the previous analysis of variance confidence intervals. The estimate of the overall mean square for each test was obtained by computing a pooled estimated mean square over both randomizations. The df for the pooled estimated mean square was taken conservatively as 234 and the labeled F for $\alpha = 0.05$ is thus 3.88 for calculating the adjusted means for the confidence intervals:

$$\tilde{\bar{Y}}_{11} - \tilde{\bar{Y}}_{12} - F_{\alpha,1,234}\,(\mathrm{MSE})\left(\frac{1}{M_{11}} + \frac{1}{M_{12}}\right) < M_{11} - M_{12} < \tilde{\bar{Y}}_{11} - \tilde{\bar{Y}}_{12} + \sqrt{F_{\alpha,1,234}\,(\mathrm{MSE})\left(\frac{1}{M_{11}} + \frac{1}{M_{12}}\right)}$$

where $F_{\alpha,1,234} = 3.88$

for $\alpha = .05$

and $\tilde{\bar{Y}}_{a.b}$ is the adjusted mean for Y given X

$$\tilde{\bar{Y}}_{ab} = \bar{Y}_{ab} - b_{yx}\,(\bar{X}_{ab} - \bar{X}_{a})$$

where $b_{yx} = r_{xy}\,\frac{sy}{sx}$

To get 99% confidence intervals after 95% intervals have computed, multiply $F_{.05,1,234}\,(\mathrm{MSE})\left(\frac{1}{M_{11}} + \frac{1}{M_{12}}\right)$

by $\sqrt{\frac{F_{.01}}{F_{.05}}} = \sqrt{\frac{6.75}{3.88}} = 1.3190$

The confidence intervals for the analysis of covariance are:

Botany unit test

Confidence intervals (95%)

$.3078 < M_{A1} - M_{A2} < 7.3944$
$1.6616 < M_{B1} - M_{B2} < 4.9992$

Confidence intervals (99%)

$1.1293 < M_{B1} - M_{B2} < 5.5315$

Zoology unit test

Confidence intervals (95%)

$-7.3454 < M_{A1} - M_{A2} < .1314$
$-1.5350 < M_{B1} - M_{B2} < 1.8626$

Physiology unit test

Confidence intervals (95%)

$-5.8311 < M_{A1} - M_{A2} < 1.4365$
$.8152 < M_{B1} - M_{B2} < 2.6076$

Cooperative Biology Test

Confidence intervals (95%)

$4.2675 < M_{A1} - M_{A2} < 11.7371$
$7.9883 < M_{B1} - M_{B2} < 6.5063$

Confidence intervals (99%)

$$3.0761 < M_{A1} - M_{A2} < 12.9285$$
$$2.4272 < M_{B1} - M_{B2} < 7.0674$$

Wausau final test

Confidence intervals (95%)

$$3.2357 < M_{A1} - M_{A2} < 10.6279$$
$$3.0560 < M_{B2} - M_{B2} < 6.5376$$

Confidence intervals (99%)

$$2.0566 < M_{A1} - M_{A2} < 11.8070$$
$$2.5007 < M_{B1} - M_{B2} < 7.0929$$

The summary of the tests of significance is shown in Table 12.

TABLE 12

SUMMARY OF THE TESTS OF SIGNIFICANCE FOR THE ACHIEVEMENT TESTS

TEST	Mean of Large-Group Presentation Students	Mean of Television Presentation Students	Analysis of Variance	Analysis of Covariance
Botany Unit Test	50.93	48.42	Signif. at .05 level	Signif. at .05 level
Zoology Unit Test	51.93	53.43	Not Signif.	Not Signif.
Physiology Unit Test	48.63	49.25	Not Signif.	Not Signif.
Genetics Unit Test	44.84	52.80	Signif. Beyond .01 Level	Signif. Beyond .01 Level
Cooperative Biology Test	45.25	40.43	Signif. Beyond .01 Level	Signif. Beyond .01 Level
Wausau Final Test	42.25	40.84	Signif. at .05 level	Signif. at .05 level

Opinionaire

In examining the responses to the opinionaire it would appear that the following conclusions may be drawn regarding the students' opinions of the televised-team teaching program:

1. A majority of the students stated that they liked the televised presentations.
2. A majority of the students appeared to like small group classroom activities, such as demonstrations, discussions, experiments, etc.
3. The students apparently preferred objective examinations.
4. Most of the students did not seem to feel uneasy about being a part of the program by the end of the year.
5. A majority of the students evidently felt that they had gained a real understanding of biological principles and concepts. However, a sizable minority was undecided.
6. A majority of the students stated that they felt that the 55 minute televised presentation was too long. However, a sizable minority felt that they were just the right length.
7. A large majority of the students apparently felt that two presentations per week was just right.
8. In rating their general impressions of the individual television presentations a majority of the students seemed to feel that the presentations (1) ranged from good to excellent in regard to subject mastery and organization; (2) ranged from very good to poor in interest and the commanding attention; and (3) that

they were able to see the television image adequately.

9. It would appear from the results of the opinionaire that the students liked having a variety of teachers present the course and going to a variety of different classroom situations.

10. In comparing the televised-team-teaching program with traditional courses, the majority of the students seemed to feel (1) that the televised-teaching-team approach was better in the amount of information presented and in the use of audio-visual techniques; (2) that the traditional courses were better in personal contact with the teacher; and (3) that the understanding of course material was either the same in both situations or better in the team. However, a sizable minority felt that understanding course material was better in the traditional type of course.

CHAPTER VI

Summary and Conclusions

Summary

The Problem

This study was designed to determine whether significant differences exist in the subject matter achievement of two groups of high school biology students when one group is taught utilizing the teacher team approach with large group sessions and small group sessions, and the other group is taught utilizing the teacher team approach with televised teacher presentations.

The Experimental Procedures

1. The achievement of students enrolled in the biology course at the Wausau Senior High School in the years 1963-64 and 1964-65 was studied in this project.
2. Each year the students enrolled in biology were sectioned into high ability and average ability groups.
3. During the 1963-64 school year, the students enrolled in biology were taught utilizing a teacher team approach which included large group presentations. During the 1964-65 school year, the students enrolled in biology were taught utilizing a teacher team approach with televised teacher presentations substituted for the large group presentations.
4. Intelligence, reading, and science achievement tests were administered to all biology students at the beginning of each school year. Students achievement in biology was measured by four unit tests and two final examinations.

Evaluation

1. Prior to the beginning of the experiment, the following tests were administered to each group of biology students:
    a. STEP Test, Form 2B, Science
    b. Nelson Silent Reading Test
    c. Henmon-Nelson Test of Mental Ability
    d. Metropolitan Science Test

2. Unit examinations in the areas of botany, zoology, physiology and genetics were administered at intervals of approximately nine weeks.

3. At the end of the school year two final examinations were administered to all biology students. One of the examinations was constructed jointly by the Wausau biology teachers and the science education staff of the University of Wisconsin; the other examination was the Cooperative Biology Test, Form X.

4. An opinionaire designed to ellicit opinions about the presentations was administered to all biology students.

Experimental Design and Statistical Analysis

1. A 2 x 2 factorial design was used in this experiment.

2. Initially the means, variances and correlation matrices were obtained for each of the four groups -- treatment combinations for each of the 10 tests.

3. Analyses of covariance were run for all unit and final examinations (except the genetics unit test), because the initial analyses indicated the groups differed prior to the experiment.

4. Confidence intervals were computed for each test.

Conclusions

Comparison of achievement test scores of large-group presentations and television presentation treatment groups.

1. Students instructed in large groups earned significantly higher scores on the botany unit test, the Cooperative Biology Test and the Wausau Final test than did the students instructed utilizing televised presentations.

2. Students instructed utilizing televised presentations earned significantly higher scores on the genetics unit test than did the students instructed in large groups.

3. There were no significant differences, as measured by the zoology unit test and the physiology unit test, in the two experimental groups.

4. All mean score differences for the biology achievement tests existed in the same direction for both the high ability and average ability students.

Opinionaire

The student opinionaire apparently indicates that generally the students liked the televised program. However, there would seem to be an indication that the large group instruction techniques previously developed by the biology staff may be more effective in the large group than on television.

Observations and Implications

Pattern of Test Scores

The unit tests were administered in this order: botany, zoology, physiology and genetics. The large-group presentation students scored significantly higher on the botany test. No significant differences existed for the scores on the zoology and physiology tests. The television presentation group scored significantly higher on the genetics test. Thus, a trend in the scores is noted, whereby the large-group presentation students earned higher scores early in the experiment while the televised presentation students earned higher scores on the last unit test.

Also to be noted is the fact that the large-group presentation students earned higher scores on both the Wausau Final test and the Cooperative Biology Test.

Technical Problems

Somewhat frustrating to the teachers of the biology team was the occurrance of technical problems in working out the "bugs" of the television system. Picture drop-out, synchronization problems, adjustment difficulties, etc. were bewildering to the didactic staff. These types of frustrations may have had a bearing on the overall effectiveness of the television phase of the experiment.

At the beginning of the second semester, the school's electricity and electronics instructor was appointed to act as the technical director of the television studio facilities. This staff addition was of invaluable aid to the team in the opinion of the biology teachers.

Another problem that created difficulty for the biology team was the delay that occurred in obtaining and installing the video tape recorder. Due to various administrative reasons, the video tape recorder was not ready for operation until the middle of the television year. Therefore, the team was not able to utilize the video tape recorder as an evaluating instrument for the presentor to observe himself.

During the first semester, demonstrations had to be performed on camera without the benefit of editing and retaping procedures.

Length of televised presentations

Due to staff and student scheduling problems and the need to operate the large group presentations in a manner identical to the non-television year, it was necessary to construct the televised presentations to occupy fifty-five minute periods. In the opinion of the biology teachers, this amount of time was too long to maintain student interest. The students appeared to suffer from muscular fatigue and boredom when required to focus their attention for almost an hour on the relatively small area of a 23 inch television receiver.

Other Considerations

A. Preparation Time

The teachers expressed the opinion, that although approximately six hours of preparation time had been allotted for the preparation of one hour of large-group presentations in previous years, that this was insufficient time for the preparation of the televised presentations which required the preparation of special audio-visual materials appropriate for use with a television camera, and which required time to rehearse the presentation in the studio with camera and technical personnel.

B. Technical Personnel

As previously mentioned, the biology team felt inadequate to cope with the technical problems of operating and maintaining a television studio. They unanimously recommended the addition of technically competant staff to the studio facilities.

C. Needed Investigations

Although the results of the statistical analysis of this study indicates that the students taught via large-group presentations generally achieved significantly higher than students taught via televised presentations, this study has pointed out the need for investigating other aspects of the utilization of televised presentations in the biology team teaching program of the Wausau Senior High School.

These other aspects should include:

1. Learning to use the television camera and video tape recorder as tools in the creative process of teaching rather than just as an

eyewitness to previously established techniques.

2. Attempting to use the television facility as a supporting didactic technique for the large-group presentations, for demonstrations, guest lecturers, field work, etc.

BIBLIOGRAPHY

(1) Anderson, Edward J. and Harkness, J. C. "Planned Variability." Nation's Schools, 65: 83-91, April, 1960.

(2) Anderson, R. H. "Three Examples of Team Teaching in Action," Nation's Schools, 65: 62-65, 102, 104, 108, 110, May 1960.

(3) Benstahoper, R. P. and Charles, D. C., "The Attention of Classroom and Television Learning," Journal of Applied Psychology.

(4) Boone, W. F., Evaluation of the U. S. Naval Academy Educational Television as a Teaching Aid. Report No. 7010, Annapolis, Maryland: U. S. Naval Academy, 1956.

(5) Brownell, John A. and Taylor, Harris A., "Theoretical Perspectives for Teaching Teams." Phi Delta Kappan, 44: 150-157, January, 1962.

(6) Carpenter, C. R. and Greenhill, L. P., An Investigation of Closed-Circuit Television for Teaching University Courses, Instructional Television Project Report No. 1, University Park, Pennsylvania; Pennsylvania State University, 1955.

(7) Catraro, P. Z., A Study in Effects of Class Size, Supervisory Status and Two-Way Communications Upon Learning and Attitudes, AF-ROTC Cadets in a Closed-Circuit Instructional Television Program, dissertation abstract 17:20; 1957.

(8) A Cooperative Study For the Better Utilization of Teacher Competencies. Third Report, June, 1957, Department of Special Studies, Central Michigan University, Mount Pleasant, Michigan.

(9) Cunningham, Luvern L., "Team Teaching: Where Do We Stand?" Administrative Notebook, Midwest Administration Center, The University of Chicago. 3: No. 8, p. 4, April, 1960.

(10) Ford Foundation. Time, Talent, and Teachers, New York: The Foundation, pp. 3-7, 1960.

(11) Fowlkes, John Guy, Making Teaching and Learning Better, Wisconsin Improvement Program, University of Wisconsin, Madison, Wisconsin, 1962.

(12) Gilchrist, Robert S., "Promising Practices in Education." Phi Delta Kappan, 41: 208-11, February; 269-74, March, 1960.

(13) Hermanowics, Henry J., "An Overview of Team Teaching." Illinois Journal of Education, 52: p. 31-35, November, 1961.

(14) Hudleson, Earl. Class Size at the College Level. The The University of Minnesota Press, p. 271, 1928.

Bibliography
(cont'd)

(15) Johnson, Robert H. and Lobb, M. Delbert, "Jefferson County, Colorado, Completes Three-year Study of Staffing, Changing Class Size, Programming, and Scheduling." *Bulletin of the National Association of Secondary School Principals*, 45: no. 261, 57-58, January, 1961.

(16) Kannar, J. H., Katz, S., and Goldsmith, P. D., *Television In Army Training: Evaluation of Intensive Television for Teaching Basic Electricity*, New York: Army Pictorial Center, 1958.

(17) Kumath, H., *Attitude Change and Learning as a Function of Prestige of Instructor and Mode of Presentation*, East Lansing, Michigan: Michigan State University, 1958, Mimeo 72.

(18) McKenna, Bernard, "Measures of Class Size and Numerical Staff Adequacy Related to a Measure of School Quality," Unpublished Ed. D. dissertation, Teachers College, Columbia University, New York, 1955.

(19) Newell, Clarence A., *Class Size and Adaptability*, New York Bureau of Publications, Teachers College, Columbia University, 1943.

(20) Paul, J. and Ogildia, J. C., "Class Media and Retention," A Journal As Explorations, No. 4, pp. 120-123, 1955.

(21) Pella, Milton O. and Poulos, Chris G., "A Study of Team Teaching in High School Biology." *Journal of Research in Science Teaching*, Vol. 1, 1963.

(22) Pertsch, Frederick C., "Some Effects of Class Size on the Educational Program in New York City Elementary Schools." *The Advancing Front of Education*, New York Society for the Experimental Study of Education, New York Thesis Publishing Company, 1943.

(23) Price, John W., "More Experience With Utilizing a New School Plant at Syosset, New York, on Contributing to Staff Use and Curriculum Development," *National Association of Secondary School Principals*, Bulletin 43, January, March, 1959.

(24) Richman, Harold, "Educational Practices as Affected by Class Size," Unpublished Ed. D. dissertation, Teachers College Columbia University, New York, 1959.

(25) Ross, Donald H. and McKenna, Bernard, "Class Size: The Multi-Million Dollar Question," Institute of Administration Research, Teachers College, Columbia University, Study, no. 11, pp. 22, 1955.

Bibliography
(cont'd)

(26) Richman, Harold, "Educational Practices as Affected by Class size," Unpublished Ed. D. dissertation, Teachers College, Columbia University, New York, 1955.

(27) Schramm, Wilbur, Education Television -- The Next Ten Years, The Institute for Communication Research, Stanford University, Stanford, California, 1962.

(28) Seibert, W. S., An Evaluation of Televised Instruction in College and Freshman Mathematics, Television Project No. 6, West LaFayette, Indiana, Purdue University, 1958, Mimeograph.

(29) Stoddard, Alexander J., Schools for Tomorrow: An Educator's Blueprint. New York: Fund for the Advancement of Education, 1957.

(30) Strait, Eugene, "Challenging the Traditional Class Size," Michigan Education Journal, 36: 261, February, 1959.

(31) "Studies of Utilization of Staff, Buildings, and Audio-Visual Aids in the Public Schools," Research Report, 1959-R17, Research Division, National Education Association, pp. 40, 1959.

(32) Trump, J. Lloyd and Baynham, Dorsey, "Focus on Change: Guide to Better Schools," Chicago: Rand McNally and Company, 1961.

(33) Trump, J. Lloyd, "Images of the Future: A New Approach to the Secondary School." Commission on the Experimental Study of the Utilization of the Staff in the Secondary School, National Association of Secondary School Principals, 1959.

(34) White, Robert W., "The Relative Effectiveness of a Team Teaching Method in High School Biology Instruction." Unpublished Ph. D. thesis University of Wisconsin, 1963.

(35) Whitsitt, Robert C., "Comparing the Individualities of Large Secondary School Classes with Small Secondary School Classes Through the Use of Structural Observation Schedule." Unpublished Ed. D. dissertation, Teachers College, Columbia University, New York, New York, 1955.

(36) Woodring, Paul, "New Directions in Teacher Education," New York: Fund for the Advancement of Education, 1947.

APPENDIX A

SUMMARY OF ANALYSIS OF COVARIANCE FOR THE BOTANY, ZOOLOGY, PHYSIOLOGY, COOPERATIVE BIOLOGY, AND WAUSAU BIOLOGY TEST

TABLE 1

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR THE ZOOLOGY TEST

Rand I

SOURCE	df	SS	MS	F
GROUPS	1	3,001.2529	3,001.2529	55.47
YEARS	1	91.1123	91.1123	1.68
G x Y	1	241.8251	241.8251	4.47
WITHIN	234	12,659.6683	54.1011	
TOTAL	237	15,993.8586		

Rand II

SOURCE	df	SS	MS	F
GROUPS	1	4,411.3162	4,411.3162	70.64
YEARS	1	153.2511	153.2511	2.45
G x Y	1	131.6340	131.6340	2.11
WITHIN	234	14,611.9266	62.4441	
TOTAL	237	19,308.1279		

TABLE 2

SUMMARY OF THE ANALYSIS OF COVARIANCE OF THE BOTANY TEST

Rand I

SOURCE	df	SS	MS	F
GROUPS	1	3,272.1354	3,272.1354	60.42
YEARS	1	815.1512	815.1512	15.05
G x Y	1	.4006	.4006	0.01
WITHIN	234	12,672.7101	54.1569	
TOTAL	237	16,760.3982		

Rand II

SOURCE	df	SS	MS	F
GROUPS	1	4,217.3859	4,217.3859	72.33
YEARS	1	583.6578	583.6578	10.01
G x Y	1	19.2425	19.2425	0.33
WITHIN	234	13,644.0227	58.3078	
TOTAL	237	18,464.3089		

TABLE 3

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR THE PHYSIOLOGY TEST

Rand I

SOURCE	df	SS	MS	F
GROUPS	1	3,019.4241	3,019.4241	47.99
YEARS	1	24.8054	24.8054	0.39
G x Y	1	83.6482	83.6482	1.33
WITHIN	234	14,722.2488	62.8156	
TOTAL	237	17,850.1238		

Rand II

SOURCE	df	SS	MS	F
GROUPS	1	4,028.5622	4,028.5622	72.76
YEARS	1	1.3544	1.3544	0.02
G x Y	1	147.9520	147.9520	2.67
WITHIN	234	12,955.1786	55.3640	
TOTAL	237	17,133.0472		

TABLE 4

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR THE COOPERATIVE BIOLOGY TEST

Rand I

SOURCE	df	SS	MS	F
GROUPS	1	2,699.1329	2,699.1329	40.95
YEARS	1	1,937.6381	1,937.6381	29.40
G x Y	1	159,3787	159.3787	
WITHIN	234	15,421.7530	65.9049	
TOTAL	237	20.217.9027		

Rand II

SOURCE	df	SS	MS	F
GROUPS	1	3,241.9690	3,241.9690	54.90
YEARS	1	2,210.7803	2,210.7803	37.44
G x Y	1	102,0110	102.0110	1.73
WITHIN	234	13,817.2215	59.0480	
TOTAL	237	19,371.9818		

TABLE 5

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR THE WAUSAU BIOLOGY FINAL TEST

Rand I

SOURCE	df	SS	MS	F
GROUPS	1	2,626.2412	2,626.2412	65.69
YEARS	1	337.6248	337.6248	8.45
G x Y	1	42.7779	42.7779	1.07
WITHIN	234	9,354.6002	39.9769	
TOTAL	237	12,361.2441		

Rand II

SOURCE	df	SS	MS	F
GROUPS	1	2,650.8357	2,650.8357	51.15
YEARS	1	410.8956	410.8956	7.93
G x Y	1	22.3019	22.3019	0.43
WITHIN	234	12,126.1126	51.8210	
TOTAL	237	15,210.1467		

APPENDIX B

OPINIONAIRE COMPLETED BY ALL BIOLOGY STUDENTS OF THIS STUDY AND TABULATED RESPONSES

Student Opinionaire, May 1965

Please complete the following survey to help evaluate the team-teaching television project. Your answers will be kept confidential and will have absolutely no bearing or your grade. This is your opportunity to put yourself in the driver's seat without the risk of any accident. If you have any comments about any of the questions, or if you wish to comment on anything not covered by this survey, please write the number of the question on the back of the last sheet of your survey then add your comment.

1. Rate each of the following by checking the appropriate column.

	Excellent	Very Good	Good	Fair	Poor
a. Televised Presentations	4	33	78	78	21
b. Laboratories					
1. Dissections	51	63	34	22	4
2. Demonstrations	15	60	85	23	2
3. Experiments	17	52	85	38	5
4. Discussions	11	38	76	43	10
5. Reviews	14	49	72	31	14
c. Discussion Periods	16	35	61	53	22
d. Exams (type of questions you like)					
1. Multiple choice	79	63	34	2	3
2. True - False	41	60	45	24	8
3. Completion	6	15	42	60	55
4. Matching	35	38	57	39	12
5. Essay	16	17	40	55	41

2. Did you feel uneasy about the course at the beginning?
79 Yes 66 No If yes, why? ____________________

If yes, do you still feel the same way? ____________________
21 Yes 74 No If yes, why? ____________________

If no, why did your feelings change? ____________________

3. Do you feel that you gained a real understanding of biological principles and concepts?

91 Yes 19 No 68 Undecided

Give reason for your answer. ____________________

4. Check each of the following:

Too Much	Just Right	Not Enough	
95	64	4	a. Length of television presentations
41	115	28	b. Length of 2 period laboratory
10	78	98	c. Length of discussion periods
46	124	14	d. Number of televised presentations per week
11	118	64	e. Number of laboratories per week
7	67	124	f. Number of discussion periods per week
24	131	34	g. Number of weekly quizes given
31	136	15	h. Number of exams - first semester
19	141	20	i. Number of exams - second semester
61	124	7	j. Length of exams
23	145	20	k. Difficulty of exams

5. A. Did you have any difficulty taking notes?
88 Yes 92 No

B. Were you helped in your note taking by the presentation on that subject?
95 Yes 51 No 38 Undecided

C. Which do you feel is the most helpful?

a. Detailed printed notes handed out - 55

b. Organizing and taking my own notes - 34

c. General printed notes handed out - 64

d. Have the teacher write complete notes as the presentation progresses - 28

e. Have the teacher write general notes as the presentation progresses - 28

f. A combination of the above - 5

g. No notetaking at all - 3

D. Did you use your notes to help your studying?

34 Always 60 Usually 76 Sometimes 10 Never

6. Rate your general impression of the television presentations as follows - place a check in the appropriate column.

	Excellent	Very Good	Good	Fair	Poor
a. Subject mastery	23	46	79	23	4
b. Organization	18	56	79	23	10
c. Interesting Presentation	2	25	94	70	26
d. Use of Voice	13	36	77	47	11
e. Use of Visual Equipment	22	54	53	37	23
f. Commands Attention	1	25	43	65	48
g. Legibility	8	31	56	61	24
h. Ability to see TV Screen	28	35	62	38	23

7. Did you like having a variety of teachers present the course?

156 Yes 18 No 11 Undecided

Reason ____________________

8. Did you like going to a variety of different classroom situations?

76 Yes 24 No 29 Undecided

Reason ____________________

9. Did you like any particular televised presentation or series of televised presentations more than the others?

86 Yes 80 No _____ If yes, which ones?

(Botany - 16, Zoology - 14, Physiology - 8, Chemistry - 1, Genetics - 43, Embryology - 22, Ecology - 8, Evolution - 6)

Give reason for your answer. (1. Interesting, 2. Well organized, 3. Injected humor, 4. A-V material helpful, 5. Prepared notes and pass out materials helpful.)

10. Did you dislike any particular televised presentation or series of televised presentations more than the others?

68 Yes 100 No If Yes, which ones? (Botany - 12, Zoology - 10, Physiology - 12, Chemistry - 23, Genetics - 10, Embryology - 10.)

Give reason for your answer. (1. Covered material too fast, 2. Material too difficult, 3. Uninteresting, 4. Boring, 5. Too easy.)

11. In your opinion, how would you compare the team-teaching-television with a regular (1 period - 5 days a week) course as to:

	Same in Both	Better in Team	Better in Regular
a. Amount of information presented	38	117	18
b. Understanding course material	44	58	76
c. Personal contact with teacher	21	25	127
d. Use of audio-visual demonstrations (movies, slides, etc.)	42	106	26

12. How many hours per week did you study biology? (Range 0 to 20 average 3.3 hours.)

Was this - 50 Enough 73 Too little 13 Too much

13. Would you like to see any other courses adapt this method of teaching?

50 Yes 57 No 37 Undecided

If Yes, which ones? (History - 24, English - 9, Math - 4, Science - 6, Social Science - 3, Electronics and Foreign Language - 1.)

APPENDIX C

WAUSAU CONSTRUCTED BIOLOGY ACHIEVEMENT TESTS USED IN THIS STUDY

Final Test - Botany

Do not write on this test. Place all your answers on the answer sheet.

1. The specialized branch of biology dealing with plant life is: a. botany; b. physiology; c. psuedology; d. zoology.

2. A complete, entire plant or animal is: a. tissue; b. organ; c. organism; d. environment.

3. The most abundant substance in plant cell walls is: a. starch; b. chromatin; c. cellulose; d. cytoplasm.

4. A cell structure found in plants but lacking in animals is: a. chloroplast; b. plasma membrane; c. vacuole; d. nucleus.

5. The life functions of plants and animals are: a. fundamentally alike; b. alike in some respects; c. different in most respects; d. totally different.

6. Bacteria in the form of straight rods are classed as: a. bacillus; b. coccus; c. spirillum; d. staphylococcus.

7. The mass of hyphae composing the plant body of molds, mushrooms, and other fungi is: a. matrix; b. mycelium; c. rhizoid; d. stipe.

8. A knoblike spore-bearing structure in bread mold is: a. sporangium, b. stipe; c. protonema; d. annulus.

9. Cell by which a flowerless plant reproduced asexually is: a. spore; b. stipe; c. sporangium; d. rhizoid.

10. A spore-bearing structure on the lower side of a mushroom cap is: a. annulus; b. capsule; c. filament; d. gill.

11. A small, threadlike filament which grows from a moss spore is: a. filament, b. hypha; c. protonema; d. rhizoid.

12. A spore-bearing structure at the tip of a stalk in the moss plant is: a. annulus; b. capsule; c. filament; d. gill.

13. Simple plants without true roots, stems, or leaves, and that lack chlorophyll, are: a. mosses; b. liverworts; c. algae; d. fungi.

14. Bread mold reproduces my means of: a. spores; b. sperms; c. seeds; d. budding.

15. A thallophyte plant consisting of an alga and a fungus living together is a: a. mold; b. kelp; c. lichen; d. mildew.

16. Some molds are helpful to man because they: a. make bread dough rise; b. are the source of antibiotics; c. produce mildew; d. form diatomaceous earth.

17. Most moss plants lack: a. vascular tissue; b. chlorophyll; c. gametes; d. rhizoids.

18. The branching, threadlike part of bread mold is the: a. leaf; b. mycelium; c. flagellum; d. sporangium.

19. The leafy generation of the moss plant is the: a. gametophyte; b. bristle; c. sporophyte; d. rhizoid.

20. Most red and brown algae: a. have true roots; b. have water vessel; c. grow in the oceans; d. lack chlorophyll.

21. Nonflowering plants that have unrolling fronds are: a. ferns; b. evergreens; c. grasses; d. fruit trees.

22. Plants that produce flowers generally reproduce by means of: a. cones; b. prothallia; c. budding; d. seeds.

23. Sixty per cent of man's food comes directly or indirectly from: a. cycads; b. conifers; c. grains; d. fruit trees.

24. All trees that bear naked seeds: a. are angiosperms; b. are gymnosperms; c. produce fruits; d. produce cones.

25. The term among the following that includes the others is: a. alternation of generations; b. gametophyte; c. sporangia; d. sporophyte.

26. Pussy willows and corn tassels are examples of: a. cones; b. spores; c. seeds; d. flowers.

27. In ferns, the leafy plant: a. is a sporophyte; b. is a gametophyte; c. lacks xylem; d. lacks phloem.

28. A plant that is classified as both an angiosperm and a monocot is: a. apple tree; b. corn; c. pine tree; d. rose.

29. The term among the following that does NOT belong with the others is: a. maidenhair fern; b. dicotyledon; c. scouring rush; d. pteridophyte.

30. Peach trees are to flowers as pine trees are to: a. leaves; b. seeds; c. spores; d. cones.

31. All plants that have flowers also: a. lack sepals; b. contain petals; c. produce enclosed seeds; d. produce fronds.

In the space on the answer sheet for each statement below (32-34) write the letter:

a. if the statement is true of algae
b. if the statement is true of fungi
c. if the statement is true of mosses
d. if the statement is true of liverworts

32. These plants have simple leaves and stemlike and rootlike parts.

33. Molds and yeast belong to this group of plants.

34. These forking, flat, ribbonlike green plants are found growing flat on moist rocks or shady soil.

35. Penicillin is a product of a: a. alga; b. mold; c. mushroom; d. bacteria.

36. Shelflike growths on tree stumps are: a. bracket fungi; b. molds; c. mushrooms; d. smuts.

37. A small dot, containing clusters of sporangia, on the under side of fern leaves is: a. mold; b. prothallus; c. rhizome; d. sorus.

38. The familiar fern we grow in pots and see in the woods is a: gametophyte generation; b. sexual generation; c. sporophyte generation; d. zygospore generation.

39. The principal absorbing tissue of a mature root is: a. cortex; b. embryonic; c. endodermis; d. epidermis.

40. A seed leaf, containing food reserves in many plants is: a. cotyledon; b. endosperm; c. micropyle; d. ovule.

41. A food storage tissue in certain seeds, including corn is the: a. cotyledon; b. endosperm; c. micropyle; d. style.

42. The stiffness of a cell due to the presence of water under pressure is: a. turgor; b. plasmolysis; c. osmosis; d. diffusion.

43. The part of a plant specialized in absorption of water is the: a. leaflet; b. lenticel; c. root hair; d. cork.

44. The growth of tree roots toward a water pipe is an example of: a. negative phototropism; b. negative geotropism; c. positive chemotropism; d. positive hydrotropism.

45. The bark tissue of a tree through which foods move downward is the: a. cork; b. cork cambium; c. cortex; d. phloem.

46. The largest number of chloroplasts in a leaf is usually in the: a. upper epidermis; b. palisade layer; c. spongy layer; d. lower epidermis.

47. A fibrovascular bundle of a monocot stem lacks: a. xylem vessels; b. phloem; c. mechanical tissue; d. cambium.

48. Seasonal activity of the cambium of a tree adds several tissues, but does not increase the amount of: a. pith rays; b. pith; c. xylem; d. phloem.

49. Annual rings of a tree are layers of large and small cells of the: a. cork; b. cambium; c. xylem; d. phloem.

50. A perfect flower always has: a. stamens; b. stamens and pistil; c. stamens, pistil, and petals; d. stamens, pistil, petals and sepals.

51. Most of the movement of water and minerals upward through a stem occurs in the: a. pith rays; b. cortex; c. xylem; d. phloem.

52. During transpiration, the leaves of a plant: a. absorb minerals; b. give off water vapor; c. release oxygen; d. take in carbon dioxide.

53. Two important functions of stems are: a. absorption and reproduction; b. storage and transpiration; c. conduction and support; d. photosynthesis and respiration.

54. Nitrogen-fixing bacteria are helpful to man because they: a. change nitrates to free nitrogen; b. change free nitrogen to nitrates; c. use nitrates made by legumes; d. decay dead plants into nitrates.

55. An essential part of a flower is the: a. stamen; b. petal; c. sepal; d. peduncle.

56. Anthers are related to stamens as ovaries are related to: a. pistils; b. filaments; c. stigmas; d. styles.

57. To be classed as an Angiosperm, a plant must: a. be a monocot; b. be a dicot; c. produce flowers; d. produce cones.

58. The plants which produce seeds that are enclosed in an ovary are: a. Angiosperms; b. Gymnosperms; c. Pteridophytes; d. Spermatophytes.

59. Activity of the cambium results in the growth in: a. length of a root; b. height of a root; c. thickness of a root.

60. When germination begins, most seeds change stored food to: a. fat; b. protein; c. sugar; d. starch.

61. The ovary of a pistil ripens to become the: a. flower; b. fruit; c. testa; d. seed.

62. The fertilized egg, or zygote, gives rise to the: a. embryo; b. endosperm; c. pistil; d. viability of a seed.

63. Water normally enters a root hair because there is: a. more; b. less; c. equal amounts of; d. more water in the soil mineral solution than in the cell substance.

64. Oxygen is given off in: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

65. The elements of a carbohydrate are reorganized into a highly concentrated energy food in: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

66. Water and carbon dioxide are given off in: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

67. The process which requires the elements from soil minerals is: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

68. Foods are simplified by enzymes in: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

69. Chemical energy is released in: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

70. Radiant energy is absorbed in: a. digestion; b. fat formation; c. photosynthesis; d. protein formation; e. respiration.

In questions 71-75 you will find four terms in a row which form a group in one way or another. The four things go together. You are to discover which one thing of 4 lettered choices is also a member of the group and mark its letter on the answer sheet.

Here is a sample question:

hat, shirt, shoes, coat
a. automobile; b. flashlight; c. gloves; d. wallet

The first group consists of things to wear and in the second set only the gloves would be worn, therefore, C is the correct answer. Now do the next five questions in the same way.

71. Mushroom, Bracket fungus, Mildew, Wheat rust
a. Odegonium; b. Spirogyra; c. Rhizopus; d. Diatom

72. Fungi, Yeast, Diatom, Algae
a. Gymnosperm; b. Dicot; c. Pteridophyta; d. Thallophyta

73. Maidenhair fern, White pine, Corn, Buttercup
a. Liverwort; b. Horsetail; c. Moss; d. Protococcus

74. Area, Concentration, Membrane, Minerals
a. Diffusion; b. Osmosis; c. Photosynthesis; d. Transpiration

75. White pine, Bright light, Potometer, Water
a. Diffusion; b. Osmosis; c. Photosynthesis; d. Transpiration

Zoology Final

DO NOT write on this test. Place all your answers on the answer sheet.

Directions: Match the animals on the left with the characteristics on the right, using letter answers. Several characteristics may apply to any one animal, but only one animal for each characteristic is correct.

A. Ameba
B. Paramecium
C. Hydra
D. Planaria
E. Earthworm

1. Swims rapidly by the action of muscles and cilia
2. Moves with setae and contraction of circular and longitudinal muscles
3. Body wall has two cell layers
4. Shape constantly changing
5. First shows primitive heart as aortic arches
6. Lowest animal to show body wall with three cell layers
7. Excretes indigestible matter through an anal spot
8. Engulfs food through the cell membrane at any point
9. Conjugates at intervals
10. Food swept into the cell along an oral groove
11. Shows bilateral symmetry and cephalization
12. A segmented animal
13. Is the most complex of those listed

14. Animals of Phylum Coelenterate are the first to: a. be free-living; b. reproduce by budding; c. develop specialized cells; d. have true organ systems.

15. A nerve ring and ventral nerve cord are found in: a. Hydra; b. Planaria; c. Earthworm; d. Sponge.

16. The first animals with true body cavities or coeloms belong to Phylum: a. Annelida; b. Platyhelminthes; c. Coelenterata; d. Porifera.

17. Among the following, the simplest animals that have an anus are: a. roundworms; b. jellyfish; c. rotifers; d. flatworms.

18. None of the animals from the protozoa to the roundworms has a: a. reproductive system; b. nervous system; c. digestive system; d. circulatory system.

19. The body of a planaria: a. lacks a digestive system; b. has three cell layers; c. includes a circulatory system; d. includes a respiratory system.

20. The leech is a relative of the: a. earthworm; b. tapeworm; c. fluke; d. Planaria.

21. An earthworm uses its nephridia to: a. digest leaves; b. eliminate solid wastes; c. excrete liquid wastes; d. produce eggs and sperms.

22. Unlike roundworms and flatworms, earthworms have: a. an anus; b. true organ systems; c. 3 cell layers; d. a segmented body.

23. The body cavity of a segmented worm is the: a. coelom; b. mantle; c. peritoneum; d. pericardial cavity.

24. The muscular structure which draws food into the mouth of an earthworm is: a. pharynx; b. aortic arch; c. crop; d. mantle.

25. Large numbers of clams and oysters are destroyed by the: a. starfish; b. squid; c. octopus; d. leech.

26. Early embryonic stages of growth in starfish indicate that they are most closely related to: a. mussels; b. sandworms; c. fish; d. oysters.

27. Starfish, by having the rays projecting from a central disk, illustrate: a. bilateral symmetry; b. radial symmetry; c. analogy; d. homology.

28. Which of the following show radial symmetry as a Phylum? a. Protozoa; b. Coelenterata; c. Platyhelminthes; d. Nematoda.

29. Which of the following first show a digestive system with 2 openings: a. Protozoa; b. Coelenterata; c. Platyhelminthes; d. Nematoda.

30. The simplest animals which show cephalization and bilateral symmetry are: a. Protozoa; b. Coelenterata; c. Platyhelminthes; d. Nematoda.

31. Arthropods with limy exoskeletons and gills belong to the class: a. Insecta; b. Crustacea; c. Arachnida; d. Chilopoda.

32. Which of the following is not a characteristic of the Phylum Arthropoda: a. segmented bodies; b. embryos develop only two tissue layers; c. blood filled body cavity; d. exoskeleton.

33. All arthropods lack: a. jointed legs; b. segmented bodies; c. a cephalothorax; d. an internal skeleton.

34. Unlike a butterfly, a grasshopper is at one time in its life: a. a nymph; b. a larva; c. an egg; d. a pupa.

35. The greatest use of bees to man is in: a. eating weed seeds; b. producing honey; c. destroying insect pests; d. pollinating flowers.

36. Insects breathe by means of spiracles and: a. tracheal tubes; b. skin gills; c. gills; d. lungs.

37. Mosquitoes and true flies often: a. carry disease germs; b. have scaley wings; c. have two pairs of wings; d. lack antennae.

38. A crayfish is to Crustacea as a spider is to: a. Insecta; b. Myriapoda; c. Arachnida; d. Arthropoda.

39. All known insects: a. undergo complete metamorphosis; b. undergo incomplete metamorphosis; c. possess an exoskeleton; d. have a skeleton of chiton.

40. All insects: a. have three pairs of legs; b. have 4 pairs of legs; c. lack antennae; d. are not segmented.

41. Most harmful Lepidoptera do their damage as: a. adults; b. larvae; c. eggs; d. pupae.

42. Because the adult lancelet has a notochord, it is classified as a: a. bird; b. vertebrate; c. chordate; d. reptile.

43. Of the following, the two most closely related animals are the: a. bird and flying squirrel; b. bat and dog; c. lizard and spider; d. starfish and goldfish.

44. In a fish, the blood absorbs oxygen in the: a. brain; b. gills; c. liver; d. heart.

45. In vertebrates, the nerve center for learning is in the: a. spinal cord; b. medulla; c. cerebellum; d. cerebrum.

46. The bony or true fishes are classified as: a. Echinodermata; b. Elasmobranchii; c. Osteichthyes; d. Cyclostomata.

47. The term among the following that includes all the others is: a. ape; b. Homo sapiens; c. man; d. primate.

48. Lampreys are: a. bony fish; b. cartilaginous fish; c. jawless fish; d. lungfish.

49. Unlike invertebrates, vertebrates have: a. true digestive systems; b. nervous systems; c. many-celled eggs; d. internal bony skeletons

50. Sharp canine teeth are to carnivores as hoofs are to: a. primates; b. placentals; c. ungulates; d. rodents.

51. The tongue of a snake functions: a. to frighten enemies; b. as a sense organ; c. in swallowing; d. to inject poison.

52. The body cavity of mammals is divided into two parts by the: a. chest; b. pleura; c. abdomen; d. diaphragm.

53. The only poisonous lizard in the United States is the: a. chameleon; b. Gila monster; c. Newt; d. Pit viper.

54. Cattle are classified as mammals mainly because: a. females produce milk; b. males produce sperms; c. females bear live young; d. females produce eggs.

55. Each of the following is a poisonous snake except the: a. black snake; b. rattlesnake; c. water moccasin; d. coral snake.

56. One advance of reptiles over amphibians is that reptiles: a. have jointed appendages; b. lay eggs that have shells; c. undergo metamorphosis; d. produce antivenin.

57. Unlike reptiles, birds have: a. two-chambered hearts; b. four-chambered hearts; c. complete three-chambered hearts; d. incomplete three-chambered hearts.

58. All warm-blooded animals have a: a. one-chambered heart; b. two-chambered heart; c. three-chambered heart; d. four-chambered heart.

59. The evaporation of moisture from man's skin helps in: a. the release of carbon dioxide; b. the diffusion of oxygen; c. regulating body temperature; d. speeding up enzyme action.

60. Unlike monkeys, man is grouped among the: a. Hominidae; b. Primates; c. Mammalia; d. Vertebrata.

61. If an animal has a notochord throughout its life, it is: a. a vertebrate; b. a chordate; c. a cephalopod; d. an arthropod.

62. The sharp, greatly developed teeth of gnawing mammals are: a. incisors; b. canines; c. premolars; d. molars.

63. The largest brain region of a mammal is the: a. olfactory; b. cerebrum; c. cerebellum; d. medulla.

64. Fertilization in mammals takes place in the: a. vagina; b. uterus; c. oviduct; d. ovary.

65. Which of the following is not characteristic of the mammals: a. feed newborn milk; b. possess hair; c. have a ventral heart; d. have a ventral nerve cord.

Directions: In the even numbered questions 66-75 you will find four terms in a row which form a group in one way or another. The four things go together. You are to discover which one thing of 4 lettered choices is also a member of the group and mark its letter on the answer sheet. In the odd numbered questions 67-75 you are to indicate what the even numbered question just preceding had in common.

Here is a sample question:

2. hat, shirt, shoes, coat
   a. automobile; b. flashlight; c. gloves; d. wallet

3. a. clothing; b. transportation; c. foods; d. entertainment

The first group (question 2) consists of things to wear and in the second set only the gloves would be worn, therefore, C is the correct answer. In question 3 A is the correct answer since question 2 had clothing in common. Do the next 10 questions in the same way.

66. Robin, Whale, Lion, Otter
    a. Shark; b. Alligator; c. Frog; d. Seal

67. a. three-chambered heart; b. lung air breathers; c. single circuit circulation; d. warm blooded.

68. Perch, Whale, Goldfish, Guppie
    a. Sea Squirt; b. Sea Lamprey; c. Lancelet; d. Acorn worm.

69. a. Vertebrates; b. Bony skeleton; c. Warm blooded; d. 4-chambered heart.

70. Frog, Tiger Salamander, Bluebird, Dog
    a. Mud Puppy; b. Bluegill; c. Grasshopper; d. Acorn worm.

71. a. gill breathers; b. land habitat; c. prehensile appendage; d. scaled skin.

72. Paramecium, Planaria; Pork-worm, Platyhelminthes
    a. Pig; b. Porkupine; c. Portugese Man-O-War; d. Platypus

73. a. digestive system with 2 openings; b. gill breathers; c. open circulatory system; d. invertebrates.

74. Tsetse fly, Housefly, Fruit fly, Horse fly
    a. Mosquito; b. Butterfly; c. Dragon fly; d. Beetle

75. a. Diptera; b. Lepidoptera; c. Insecta; d. Arthropoda.

Essay questions. Do two of the three questions.

A. The mammals exceed all other vertebrates in efficiency of the reproductive process. Compare mammalian reproduction with that of the lower vertebrates and list its points of greater efficiency.

B. Discuss the improvement in efficiency of distributing oxygenated blood from the fish to the frog to the reptile to the bird and mammal.

C. What is the importance of the development of ectoderm, mesoderm, endoderm, and the body cavity in animal structure.

Final - Human Physiology

Place all your answers on the answer sheet. DO NOT write on this test.

1. A band of fibrous tissue which fastens a muscle to a bone is: a. ligament; b. tendon; c. epithelium; d. cartilage.

2. Lubricating secretion in a joint is: a. blood; b. lymph; c. synovial fluid; d. mesentery.

3. A human tissue which is not a connective tissue is: a. bone; b. cartilage; c. muscle; d. blood.

4. Maltase, sucrase, and lactase are enzymes of the intestinal fluid which act on: a. sugars; b. starches; c. fats; d. proteins.

5. A digestive fluid which acts on all three classes of foods is secreted by the: a. stomach; b. liver; c. pancreas; d. intestine.

6. Deficiency diseases result from lack of sufficient: a. vitamins; b. fats; c. carbohydrates; d. proteins.

7. An end product of starch digestion is: a. glycerol; b. glucose; c. fatty acids; d. amino acids.

8. The liver is an important organ in: a. storing fatty acids; b. producing digestive enzymes; c. emulsifying carbohydrates; d. deaminizing amino acids.

9. Proteins are to pepsin as starches are to: a. ptyalin; b. mucus; c. hydrochloric acid; d. glycogen.

10. The body process that releases energy is: a. elimination; b. oxidation; c. digestion; d. peristalsis.

11. Sunshine is important to the body in the production of: a. amino acids; b. fats; c. vitamin A; d. vitamin D.

12. Pouring water from vegetables down the drain wastes mainly: a. iron; b. riboflavin; c. vitamin A; d. phosphorus.

13. If a baby is deficient in vitamin D, his body will: a. lack prothrombin; b. lack respiratory enzymes; c. develop kidney stones; d. develop rickets.

14. Scurvy can be treated with large amounts of: a. inexpensive meats; b. cod liver oil; c. vitamin C; d. thiamin.

15. If the body is deficient in iron, the blood: a. cells carry less oxygen; b. contains thinner plasma; c. fails to clot properly; d. includes fewer white cells.

16. The body makes vitamin A from: a. ascorbic acid; b. folic acid; c. carotene; d. stigmasterol.

17. The major use of amino acids in the body is for: a. growth; b. energy; c. storage; d. respiration.

18. The body requires calcium for each of the following except: a. clotting of blood; b. functioning of nerves; c. prevention of heat exhaustion; d. building bones.

19. The chief corpuscle factory of a bone is the: a. red marrow; b. yellow marrow; c. intestine; d. arteries.

20. The chemical phases of digestion are accomplished by: a. hormones; b. acids; c. enzymes; d. alkalines.

21. The most oxygenated blood flows through veins of the: a. pulmonary circulation; b. systemic circulation; c. renal circulation; d. portal circulation.

22. Blood vessesl whose walls are best adapted for diffusion of substances are: a. capillaries; b. arteries; c. veins; d. lymphatics.

23. When you exhale, your: a. rib muscles relax; b. lungs increase in size; c. windpipe decreases in size; d. diaphragm contracts.

24. A major factor in controlling the rate of breathing is the amount of: a. carbon dioxide in the blood; b. hemoglobin in the red corpuscles; c. blood in the heart; d. water in the blood.

25. A person with normal blood volume and white cell count but low red cell count is suffering from: a. hemophilia; b. pernicious anemia; c. leukemia; d. hemmorhage.

26. The greatest effort of the heart is exerted by the: a. rt. auricle; b. rt. ventricle; c. left auricle; d. left ventricle.

27. The blood serum containing antibodies against disease is the: a. albumin; b. globulin; c. fibrinogen; d. hemoglobin.

28. Serum fibrinogen in blood is essential in: a. clotting; b. carrying food; c. carrying waste products; d. carrying oxygen.

29. During the basal metabolism test, accurate measurement is made of: a. the pulse rate; b. oxygen consumed; c. heart action; d. blood pressure.

30. A vitamin essential in the clotting of blood is: a. A; b. B; c. C; d. K.

31. Worn-out red blood cells are filtered out of the blood stream in the: a. spleen; b. red bone marrow; c. stomach; d. small intestine.

32. An extremely high white cell count is a symptom of: a. anemia; b. hemophilia; c. leukemia; d. Rh factor complication.

33. For every 100 cc. of water the kidneys receive from the blood, the blood reabsorbes about: a. 10 cc.; b. 37 cc.; c. 78 cc.; d. 99 cc.

34. Urea and salt are removed from the blood by the sweat glands and: a. villi; b. lungs; c. large intestine; d. kidneys.

35. The cell islets of the pancreas: a. contain ducts; b. produce insulin; c. control calcium metabolism; d. regulate height.

36. The gonadotropic hormones from the pituitary gland stimulate the: a. gall bladder; b. liver; c. parathyroid glands; d. reproductive glands.

37. Somatotropic hormone of the pituitary gland influences: a. use of sugar by cells; b. maturing of the reproductive organs; c. water content of the blood; d. growth of the skeleton.

38. A large amount of iodine is concentrated in: a. thyroid hormone; b. insulin; c. ACTH; d. parathormone.

39. The pituitary hormone ACTH causes the: a. adrenal glands to produce cortisone; b. pituitary gland to produce prolactin; c. white corpuscles to increase rapidly; d. capillary walls to break easily.

40. Too little parathyroid hormone may result in: a. myxedema; b. toxic goiter; c. diabetes; d. tetany.

41. Sweat glands, oil glands, and nerve endings lie in the: a. epidermis; b. dermis; c. muscle; d. endothelium.

42. Endocrine secretions reach various organs through: a. tubes; b. the nervous system; c. the circulatory system; d. the digestive secretions.

43. Sugar diabetes results from insufficient production of: a. epinephrin; b. insulin; c. estrogen; d. maltase.

Directions: Indicate which endocrine gland is involved in each of the following body changes in questions 44-48.

44. The rate of basal metabolism is greatly reduced; the patient complains of being tired and, often, increases in weight. a. parathyroid; b. thyroid; c. pineal; d. thymus.

45. A person, during emotional stress, has abnormal strength due to an increase in heart action and blood pressure and release of sugar from the liver. a. adrenal cortex; b. adrenal medulla; c. pancreas; d. pituitary.

46. The person fails to grow normally and, though remaining small, is proportioned normally and has normal intelligence. a. ovary; b. testes; c. pancreas; d. pituitary.

47. The person cannot use blood sugar and may lapse into a coma;

sugar appears in the urine in great quantity. a. pancreas; b. pineal; c. thymus; d. adrenal.

48. A boy's voice deepens due to growth of the larynx, the beard starts to grow, and sexual maturity is reached. a. testes; b. ovaries; c. pancreas; d. adrenals.

49. The brain region in which intelligence and emotions are centered is the: a. cerebrum; b. cerebellum; c. medulla; d. pons.

50. The space between nerve endings is: a. dendrite; b. reflex arc; c. axon; d. synapse.

51. The brain region which coordinates muscular activity is the: a. cerebrum; b. cerebellum; c. medulla; d. pons.

52. The brain region controlling activity of the internal organs is the: a. cerebrum; b. cerebellum; c. medulla; d. hypothalmus.

53. The cerebellum is the center of: a. breathing; b. flow of gastric juice; c. thought; d. muscular co-ordination.

54. Seeing is to the cerebrum as reflexes below the neck are to the: a. medulla; b. spinal cord; c. cerebellum; d. midbrain.

55. In effects produced on the body, stimulation is to a parasympathetic nerve as relaxation is to a: a. sympathetic nerve; b. dorsal root nerve; c. cranial nerve; d. sensory nerve.

56. The "reaction time" of a reflex arc is the time required for: a. the motor neuron to react; b. the person to respond to a stimulus; c. a stimulus to inhibit a response; d. an impulse to reach the spinal cord.

57. A chemical change occurs when nerve impulses pass from one neuron to another across: a. cell bodies; b. axons; c. synapses; d. dendrites.

58. The semi-circular canals function in: a. touch; b. equilibrium; c. hearing; d. taste.

59. A reflex action involves: a. a sensory nerve and the spinal cord; b. a sensory nerve, spinal cord, and motor nerve; c. a sensory nerve, spinal cord, cerebellum, and motor nerve; d. a sensory nerve, spinal cord, cerebrum, and motor nerve.

60. The chemical substance secreted by the end plate of an axon is: a. tri-nitro-touline; b. acetycholine; c. cholesterol, d. synovial fluid.

61. Impulses travel toward the spinal cord along: a. motor nerves; b. sensory nerves; c. association nerves; d. reflex arcs.

62. Visual purple functions in vision in: a. bright light; b. dim light; c. color; d. is not involved in vision.

63. The most widely accepted theory in regard to the nature of a nerve impulse is the: a. cell theory; b. electric theory; c. motor theory; d. membrane theory.

64. Nerve impulses are: a. strictly electrical; b. self-sustaining; c. strictly chemical; d. pushed, as with electrons.

65. The egg cells of a mammal are produced in the: a. oviducts; b. ovaries; c. sperm ducts; d. testes.

66. In most mammals, fertilization occurs in the: a. uterus; b. ovary; c. testes; d. oviduct.

67. Carbon dioxide and other wastes diffuse out of the capillaries of a mammalian embryo into the mother's capillaries in the: a. placenta; b. umbilical cord; c. ovary; d. ureters.

68. In mammals, the placenta: a. surrounds the umbilical cord; b. attaches the embryo to the uterus; c. carries food into the embryo; d. contains only the mother's capillaries.

69. Sexual reproduction involves: a. 1 parent; 2 parents; c. parthenogenesis; d. androgenesis.

70. Asexual reproduction involves: a. 1 parent; b. 2 parents; c. parthenogenesis; d. androgenesis.

71. Secondary sex characteristics are controlled by: a. enzymes; b. vitamins; c. hormones; d. voluntary nerve stimulation.

72. A human embryo normally develops in the: a. ovary; b. uterus; c. vagina; d. Fallopian tube.

73. Male sex hormones are produced by: a. interstitial cells; b. eipdymes; c. prostate gland; d. seminal vesicle.

74. A menstrual cycle is controlled by: a. brain; b. sex hormones; c. the uterus; d. endrogen.

75. The effects of human sex hormones usually become noticeable: a. at birth; b. during early teens; c. after marriage; d. are never noticeable.

Essay question:

A. Discuss the relative advantages and disadvantages of oviparous, ovoviviparous, and viviparous methods of reproduction.

Test #10 - Biochemistry & Genetics

DO NOT write on this test. Place all answers on the answer sheet.

1. Showed that CH_4, NH_3, and H_2O can be combined to form amino acids: a. Von Schnikelfritz; b. Jones; c. Miller; d. Gugenheim.

2. Reaction involving trading of atoms: a. synthesis; b. decomposition; c. rearrangement; d. exchange.

3. Composed of proteins and nucleic acids; a. polysaccharide; b. nucleoproteins; c. amino acids; d. methane.

4. Reaction involving combining of two or more substances: a. exchange; b. synthesis; c. decomposition; d. rearrangement.

5. Light trap method of adding to world food supply: a. parasitism; b. animalism; c. chemosynthesis; d. photosynthesis.

6. Has bond capacity of 2: a. carbon; b. oxygen; c. nitrogen; d. hydrogen.

7. Ability of atoms to link to and remain attached to other atoms: a. bonding; b. exergonic; c. endogonic; d. decomposition.

8. Has a bond capacity of 4: a. carbon; b. hydrogen; c. nitrogen; d. oxygen.

9. Reaction involving breakdown of a compound to two or more substances: a. exchange; b. synthesis; c. decomposition; d. rearrangement.

10. Composed of glycerin and fatty acids: a. sugars; b. fats; c. proteins; d. amino acids.

11-16. The following substances are listed without regard for degree of complexity.

A. amino acids B. nucleoproteins C. proteins D. purines E. sugars
Complete each of the following questions (11-16) using the lettered choices given above. A letter may be used more than once.

$$CH_4 + \left.\begin{matrix} CH_4 \\ H_2O \\ NH_3 \end{matrix}\right\} \longrightarrow \left\{\begin{matrix} \underline{(11)} \\ \text{glycerin} \\ \text{fatty acids} \\ \underline{(12)} \\ \text{pyrimidines} \\ \underline{(13)} \end{matrix}\right.$$

sugars + sugars = polysaccharides
amino acids + amino acids = (14)

purines
pyrimidines + (15) + phosphates = nucleotides
nucleotides + nucleotides = (16)

17. A cross between two different strains or species of plants or animals: a. hybrid; b. gene; c. meiosis; d. dominant.

18. A trait which appears in a hybrid: a. blended characteristic; b. recessive characteristic; c. dominant characteristic; d. neutral characteristic.

19. Reduction division of chromosomes resulting in an n number of chromosomes: a. assimilation; b. reproduction; c. mitosis; d. meiosis.

20. A rod-shaped structure formed in a nucleus during its division: a. chromatin; b. chromosome; c. centrosome; d. spindle fiber.

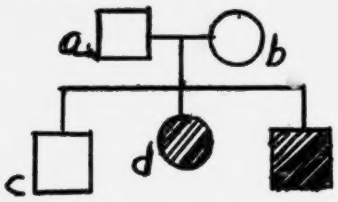
21. A tiny particle which bears a trait in heredity: a. chromosome; b. hybrid; c. gene; d. diploid.

22. A trait which may be present without appearing in a hybrid: a. haploid; b. recessive; c. dominant; d. diploid.

23. Equal division of chromosomes during body cell formation: a. mitosis; b. meiosis; c. reproduction; d. reduction.

24. The basis of modern genetics was the work done with garden peas by: a. Avery; b. Mendel; c. Morgan; d. Blakeslee.

25. Since straight hair is recessive (shown in black in the diagram at the right), the only person who might be pure for curly hair is number: a. a; b. b; c. c; d. d.



26. If in a breeding experiment 50% of the offspring were ss, the parents were probably: a. SS x ss; b. Ss x Ss; c. Ss x ss; d. ss x ss.

27. Today scientists believe that each of the following may be true of genes except that: a. they are a part of the chromosomes; b. they produce their effects through enzyme action; c. each is a molecule of DNA; d. they are located in the microscomes.

28. The pink color of the four-o'clock flower results from: a. two genes for pink; b. one gene for red and one for white; c. one gene for pink and one for white; d. one gene for pink and one for red.

29. To learn whether a black guinea pig is pure black or hybrid black, one should cross it with a guinea pig that is: a. mutant; b. white; c. pure black; d. hybrid black.

30. If one parent of a brown mouse (recessive) is brown and the other is black, the gene make-up of the black mouse is: a. BB; b. bb; c. Bb; d. B.

31. If the genotype of a dihybrid plant is XxRr, a gamete may not be: a. XR; b. Xr; c. Rr; d. xR.

Each of the statements in items 32-34 illustrates one of the principles (a-d) shown below. On your answer sheet indicate the letter of the principle illustrated.

a. dominance
b. incomplete dominance
c. gene segregation
d. independent assortment

32. Pink snapdragons result from crossing red snapdragons with ivory snapdragons.

33. Both tall and short pea plants may have wrinkled seeds.

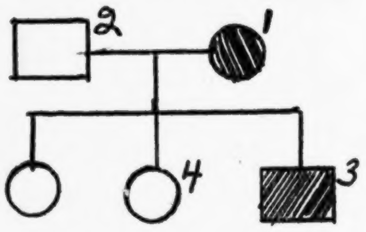
34. When pure gray mice are crossed with white mice, all the offspring are gray.

35. Identical twins result from the fusion of: a. one egg and one sperm; b. one egg and two sperms; c. two eggs and one sperm; d. two eggs and two sperms.

36. When two organisms, each hybrid for the characteristic, are crossed, large numbers of offspring will show a phenotype ratio of about: a. 1:1; b. 3:1; c. 15:1; d. 9:3:3:1.

37. If the sperm cell of an earthworm has 16 chromosomes, a muscle cell has: a. 4 chromosomes; b. 8 chromosomes; c. 16 chromosomes; d. 32 chromosomes.

38. Since normal shaped ear lobes are recessive (shown in black in diagram), a female who is hybrid for cup shaped lobe is number: a. 1; b. 2; c. 3; d. 4.



39. In a test cross, dominant appearing offspring is crossed with: a. mutant; b. hybrid; c. pure dominant; d. recessive.

40. The blue color Andalusian fowl results from: a. one gene for blue and one gene for black; b. one gene for blue and one gene for white; c. one gene for black and one for white; d. two genes for blue.

Questions 41-44 refer to the following paragraph.

A man with hemophilia marries a woman of blood type O with 2 genes for normal blood clotting. They had four children, 2 boys and 2 girls. Two of the children had type A blood and 2 had B blood.

41. The father had blood type: a. A; b. B; c. AB; d. O.

42. The gene makeup for blood type of two of the children was: a. AO; b. AA; c. AB; d. BB.

43. The gene for hemophilia was inherited: a. by all children; b. by none of the children; c. only by sons; d. only by daughters.

44. The gene for hemophilia is: a. on Y chromosome; b. on X chromosome; c. dominant gene; d. plasma gene.

45. Rate of mutation in fruit flies has been increased most rapidly by: a. artificial selection; b. natural selection; c. colchicine; d. X ray.

46. Fruit flies are frequently used in genetic experiments mainly because they: a. are very small in size; b. reproduce rapidly; c. have very small chromosomes; d. have no reverse mutations.

47. In fruit flies the trait of bent wings or no wings are: a. recessive abnormal traits; b. dominant normal trait; c. useful mutation; d. sex linked trait.

48. The number of chromosomes present in the nucleus of each human egg or sperm is: a. 96; b. 36; c. 46; d. 23.

49. The type of cell that has only one half a set of chromosomes is: a. red blood cell; b. white blood cell; c. sex cell; d. nerve cell.

50. After cross pollination a flower is covered with a paper bag to: a. keep out light; b. help the seed develop; c. keep out other pollen; d. prevent self pollination.

51. Colchicine is a chemical used: a. in hybridization; b. in line breeding; c. to increase chromosome number; d. to change the sex of an organism.

52. A popular breed of beef cattle is the: a. Guernsey; b. Hereford; c. Ayrshire; d. Jersey.

53. Luther Burbank was led into the field of plant breeding by a chance discovery concerning the: a. potato; b. daisy; c. plum; d. tomato.

54. A red rose growing on a branch of a white variety is an example of: a. hybridization; b. a variation; c. a bud-mutation; d. line breeding.

55. The new McIntosh apple has four sets of chromosomes. This number is referred to as the: a. haploid number; b. diploid number; c. triploid number; d. tetraploid number.

56. In an experiment involving cutting an ameba in half into a nucleated part and an enucleated part which of the following was not proven: a. a nucleus is necessary to maintain life; b. nuclear effects are long range; c. a nucleus is not necessary to indefinitely continue life; d. a nucleus is necessary to maintain growth.

57. In an experiment involving the transplanting of a radioactive nucleus into a non radioactive cytoplasm without a nucleus which of the following was illustrated: a. that the nucleus is related to RNA production; b. that there is no relationship between the nucleus and the cytoplasm; c. that the nucleus cannot be made radioactive; d. that radioactivity cannot be used to determine nuclear effects.

58. In a series of experiments involving RNA and protein formation, which of the following was proven: a. proteins are manufactured in the nucleus; b. there is a direct ratio between RNA present and protein present; c. there is no relationship between RNA and protein production; d. the function of RNA is unknown.

59. Picking the same traits for breeding year after year is: a. selection; b. incomplete dominance; c. homozygous; d. heterozygous.

60. Which of the following usually results in detrimental effects: a. a monohybrid; b. a genotype; c. a phenotype; d. mutation.

61. Which of the following can be produced artifically by X ray: a. cross breeding; b. mutation; c. environment; d. inbreeding.

62. The crossing of two different species of plant or animal is: a. mutation; b. F_2; c. phenotype; d. cross breeding.

63. A heterozygous brown eyed man married a blue eyed woman. What would be the expected phenotype ratio for blue eyed children from this cross: a. 1/4; b. 1/2; c. 3/4; d. 7/8.

64. Breeding in which only the best of a species are bred for many generations is: a. mutation; b. selection; c. half breed; d. offspring.

65. In mice if yy equals gray and Yy equals yellow, what ratio can you predict for an individual mouse being a yellow male: a. 1/4; b. 1/3; c. 1/2; d. 3/4.

66. If two parents are of blood type A their children could be: a. group A only; b. group A and O; c. groups A and B; d. group O only.

67. If you would cross a hybrid tall pea plant with a short one, your expected phenotype ratio would be: a. 1/3 tall, 2/3 medium, 1/3 short; b. 1/4 tall, 2/4 hybrid; 1/4 short; c. 1/2 tall, 1/2 short; d. all tall.

68. A color blind woman will pass the gene for color blindness to: a. all of her children; b. her sons only; c. her daughters only; d. 1/2 her sons.

69. Hemophilia is inherited: a. by mutation; b. as a sex linked character; c. as a desirable character; d. only by kings and queens.

70. In two parents both of whom were hybrid for taste and eye color (AaBb), if the father was heterozygous for curly hair (curly is dominant to straight hair) and the mother is homozygous recessive for hair type, what is the probability that this couple would have 2 blue eyed, non-taster, curly haired girls in a row: a. 9/2,048; b. 9/32; c. 1/4,096; d. 1/64.

Essay questions:

A. Explain the changes in chromosome number which occur during meiosis and fertilization, and tell why these changes are necessary in preserving the proper number of chromosomes in an organism.

B. In cattle, black coat and hornless are dominant to red coat and horned. A pure strain black hornless bull was mated to a red, horned cow. Over a period of time, seven calves were produced; 4 were black and hornless cows and 3 black and hornless bulls. What would be the probability of producing a red, horned bull by crossing two of the F_1 offspring? Show your work.

THE WAUSAU BIOLOGY TEST

BIOLOGY - Final Exam

Write your name and class designation on the answer sheet only. DO NOT WRITE ON THIS TEST FORM.

GENERAL DIRECTIONS: Select the best choice to complete each of the following statements. Do not turn this page until the teacher tells you to do so. There is only one correct answer to each question. Use the answer sheet provided. Mark an X under the letter you have chosen as the answer which corresponds with the question asked. DO NOT place your answer on this test. Do not waste too much time on any one question. If in doubt make as intelligent a guess as possible, but avoid wild guessing since wrong answers will result in a subtraction from the number of correct answers. Be sure to mark an answer for each question. Work as quickly and as accurately as you can.

1. Human sperms and eggs are similar in which of the following respects? a. They have the same number of chromosomes in their nuclei. b. They move about equally well. c. They have the same relative amount of cytoplasm surrounding their nuclei. d. About the same number of each is produced. e. They are of about the same weight.

2. The dividing of a full grown ameba to form two daughter cells is an example of: a. budding; b. conjugation; c. meiosis; d. sexual reproduction; e. simple fission.

3. You are employed as a biological expert on an exploratory space probe. After landing on a strange planet, your fellow scientists bring a specimen to you for classification. As you examine the specimen you note certain things about it. It is obviously multicellular and capable of movement. You analyze a small section from its outer surface and find no evidence of cellulose in its cell wall. Your specimen could be: (choose the one best term) a. an Alga; b. Animal; c. Reptile; d. a Spermatophyte; e. Vertebrate.

4. More study reveals that the specimen possessed a brain and dorsal nerve cord. It is reasonable to assume that the specimen could be: a. an Arthropod; b. Chordate; c. an Invertebrate; d. a Mollusk; e. a Prechordate.

5. Further examination reveals that the specimen has an endoskeleton, a heart, and a closed circulatory system. It could be: a. an Arthropod; b. a Bird; c. an Invertebrate; d. a Reptile; e. a Vertebrate.

6. Further study revealed that the specimen had a complete digestive tract, an air breathing respiratory system, marrow filled bones, a 4-chambered heart, and was warm blooded. It could be: a. Amphibian; b. Bird; c. Fish; d. Mammal; e. Reptile.

7. Study of other living specimens of its kind showed they were capable of having young produced alive and females produced milk for the offspring. If this specimen possessed the power to think and reason it could be: a. ape; b. cat; c. dog; d. man; e. rodent.

8. What is the function of tendons? a. They bind bones together at joints. b. They cover the ends of bones. c. They attach muscles to bones. d. They support parts of the body such as the trachea, external ear, or the end of the nose. e. They form shock absorbing pads between the vertebrae.

9. The ectoderm of the embryo gives rise to the: a. blood vessels; b. central nervous system; c. lining of the digestive tract; d. liver; e. lungs.

10. Light energy is first translated into nerve impulse in the: a. anterior chamber; b. ciliary body; c. lens; d. retina; e. vitreous humor.

The following key is to be used in answering questions 11-15. The same answer may apply in several situations.

KEY: A. fat synthesis B. photosynthesis C. protein synthesis
D. respiration E. starch synthesis

11. Which of the above processes requires an energy source outside the plant?

12. Which process results in the release of energy?

13. If the sun were completely blotted out, which process would cease immediately?

14. In which process are the nitrates of fertilizers used?

15. In which process is chlorophyll necessary?

16. One of the most marked differences between animal cells and plant cells is: a. Plant cells usually have one or more vacuoles; b. Animal cells ordinarily have a nucleolus within the nucleus; c. Animal cells have their nuclear chromatin attached to the lignin fibers; d. Nucleoplasm is unique to the animal cell; e. Plant cells usually have relatively thick rigid walls.

17. The basic organic substance from which more complex foods are synthesized in the plant is: a. amino acid; b. fatty acid; c. glucose; d. mineral salt; e. water.

18. The protoplasm of a typical living cell in the human body contains carbohydrates, fats, proteins, enzymes, mineral salts, and water. Most important in the development of new protoplasm are the: a. carbohydrates; b. fats; c. proteins; d. enzymes; e. mineral salts.

19. The portion of the protoplasm which is chiefly responsible for coordinating and controlling the chemical and physical changes which result in the production of more protoplasm is the: a. nucleus; b. plasma membrane; c. cytoplasm; d. chloroplast; e. centrosome.

20. A scientist went into a village whose population was evenly divided between natives of the village and a group of immigrants. He was testing a serum which was supposed to protect against a particular disease, so he gave the serum to the natives and nothing to the immigrants and later compared the number of cases of the disease in each group. This procedure could have been improved by doing which one of the following? a. Inject the natives with the full amount of serum, and inject the immigrants with half the amount of the serum and compare results; b. Inject the natives with the serum and half the immigrants with the serum and compare results; c. Inject the natives with the serum and inject the immigrants with a harmless inactive solution so the psychological reaction is eliminated; d. Inject all persons in the village with

the serum and compare the number of cases of the disease which occur during the next six months with the number of cases which occurred during the six months just prior to the injections; e. Inject half the natives with serum, the other half with a harmless, inactive solution, and inject half the immigrants with the serum and the other half with the harmless solution and compare results.

21. A 15 year old boy ran up three flights of stairs. Which of the following would best describe the results of this activity: a. His heart rate would increase temporarily and return to normal in a few minutes if he is healthy; b. His breath rate would increase, but the blood pressure would decrease proportionately; c. His heart rate, blood pressure, and breath rate would increase temporarily; d. There would be no measurable change in heart rate, blood pressure or breath rate; e. An increase in breath rate would be counteracted by a decrease in heart rate and blood pressure.

22. The best explanation for the above occurrance is: a. The body is able to adjust to physical exercise internally without showing any radical external symptoms; b. Exercise requires immediate supplies of oxygen and food to release energy. c. Certain metabolic activities are greatly increased during exercise and the raw materials and by-products of oxidation must be transported more readily than when at rest; d. Scientists have not as yet been able to determine a satisfactory answer for this phenomenon; e. None of the choices listed for the preceding question are correct, therefore, there can not be a best explanation.

23. Which one of the following is an example of a conditioned reflex? a. the knee jerk as it occurs when a sharp blow is struck just below the knee cap of the crossed leg; b. the building of a cell in the honey comb of a bee; c. watering of the mouth when one smells newly baked bread; d. the crying of an infant when it feels the experience of being dropped; e. the digestion of food as it passes through the digestive tract.

24. The cambium of a stem functions in: a. protection; b. support; c. food storage; d. photosynthesis; e. production of new cells.

For the next five questions (25-29) select the principle which best applies, then mark the corresponding answer place.

A. Water is a basic medium for all life processes.

B. Food is the only form in which matter and energy are utilizable by living things.

C. Photosynthesis is the link between non-living energy resources and living organisms.

D. Cellular respiration is a process of utilizing energy in food.

E. Diffusion is the basic mechanism of transport.

25. Oxygen-carbon dioxide exchange in the alveoli is effected through thin membranes.

26. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + \text{energy} + 6H_2O$

27. $6CO_2 + 12H_2O + \text{energy} \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

28. Dried fruits, vegetables and fish are not likely to deteriorate as readily as fresh ones.

29. The developing human embryo is supplied nourishment and oxygen through the placenta.

30-31. Experiment: A number of corn grains were carefully planted upside down (i.e. with the end from which the root normally grows pointing up).

30. Several weeks after sprouting or germinating: a. both roots and stems grew downward; b. roots and stems ceased growing; c. roots grew downward and stems grew upward; d. roots grew upward and stems grew downward; e. both roots and stems grew upward.

31. The best reason for your answer to the above question is: a. roots grow downward and stems grow upward; b. stems could not reach sunlight which is necessary for photosynthesis; c. gravity influences the growth of both stems and roots; d. differential growth rates of both roots and stems are responsible; e. the plant could not otherwise survive.

32. The uterine placenta in humans: a. serves as an intermediate organ of nutrition, respiration, and excretion for the developing embryo; b. is a sac containing the fluid in which the developing embryo is suspended; c. produces a hormone which helps to maintain pregnancy; d. is a sac which absorbs and stores all embryonic waste products until birth occurs; e. is the cord attached to the umbilicus of the embryo.

33-37. The following animals are listed without regard for degree of complexity.

A. Grasshopper B. Hydra C. Perch D. Planaria
E. Roundworm

Characteristics listed below appear in one or more of the above animals. Mark the letter of the simplest animal in which each characteristic is found.

33. bilateral symmetry

34. circulatory system

35. jointed legs

36. division of labor among cells

37. triploblastic (development of 3 embryo cell layers)

38-42. For each of the items mark the letter from the following list, which indicates the narrowest or smallest catagory or classification, which includes both animals.

A. kingdom B. phylum C. class D. genus E. species

38. snake and bird

39. Acetebularia mediterrania and Acetebularia crenulata

40. club moss and fern

41. sugar maple and red maple

42. whale and fish

43. Smooth muscles are innervated by: a. the autonomic nervous system; b. the central nervous system; c. the peripheral nervous system; d. all of the above; e. none of the above.

44. One significant difference between roots and stems is that: a. stems grow in length and circumference while roots grow only in length; b. stems are always above the ground while roots are always below the ground; c. stems are positively geotropic while roots are negatively geotropic; d. stems are sometimes used for storage while roots are not; e. branch roots originate in the pericycle while branch stems do not.

45. A plant which has roots, stem, leaves and bears seeds but not flowers could be a: a. fern plant; b. maple tree; c. moss plant; d. spruce tree; e. wheat plant.

46. A motor neuron carries impulses from the: a. receptor to the effector; b. effector to the receptor; c. receptor to the spinal cord; d. sense organ to the connecting neuron; e. spinal cord to the effector.

47. An example of asexual reproduction is: a. the fusion of gametes in the green alga, spirogyra; b. conjugation in paramecia; c. a potato plant growing from a tuber; d. an oak tree growing from an acorn; e. the development of a queen bee from a larva fed a special diet by the worker.

48. A catalyst is: a. a substance which affects the rate of a chemical reaction; b. a powerful oxidizing agent; c. a substance that does not take part in a chemical reaction; d. a strong electrolyte; e. the negative pole of an electrolytic cell.

49. Which of the following plant tissues is similar in structure and function to the epithelial tissue of animals? a. meristem tissue; b. epidermal tissue; c. parenchyma; d. vascular tissue; e. supporting tissue.

50. The principle of "division of labor" in biology involves: a. the production of varied agricultural crops; b. competition between organisms for the needs of life; c. differentiation of cells into tissues having different functions; d. growth so that there are more cells to do the work; e. all of these.

51. In using scientific method, one should never: a. make guesses; b. use facts from authority; c. repeat another person's work; d. base his conclusions on anything but experimental data; e. let his own prejudice influence his conclusions.

For items 52-56 select from the key the body system of which the organ forms a part. In those cases wherein an organ serves two or more systems, select the one of primary importance.

A. Digestion B. Excretion C. Reproduction D. Nervous
E. Skeletal

52. Glomerulus

53. Sternum

54. Pylorus

55. Duodenum

56. Ganglia

57. Among the following statements select the one which is not true. a. The protoplasm of every living cell is identical with that of every other living cell; b. Protoplasm is a complex colloidal system; c. Protoplasm is composed of chemical elements all of which may be found in non-living systems; d. Among the common constituents of protoplasm are water and mineral salts; e. The protoplasm within a cell shows division of labor.

58. The statement "The cell is the unit of structure, function, and reproduction of the living organism" represents the: a. organismal concept; b. definition of a cell; c. protoplasmic concept; d. species concept. e. cell theory.

For items 59-67 select from the key the most appropriate or closely related phrase and mark the corresponding answer space.

KEY: A. Common to all life. B. Characteristically found only in plants. C. Characteristically found only in animals. D. Characteristically found in neither animals nor plants.

59. Digestion

60. Respiration

61. A nervous system

62. Absorption

63. Cell protoplasm enclosed within cellulose walls

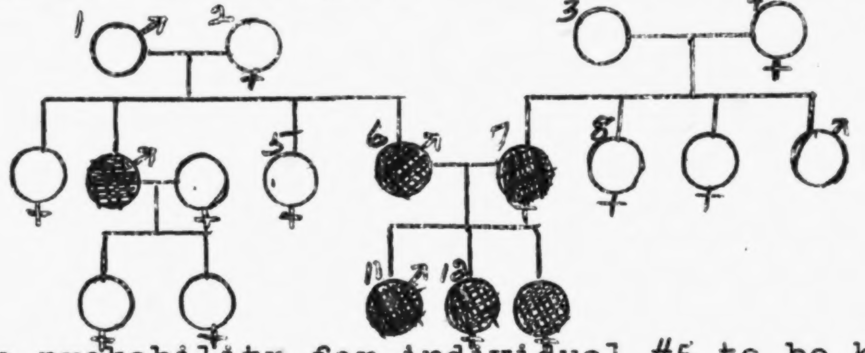
64. Secretion

65. Tissues bathed in salt solution

66. Growth

67. Irritability (responsiveness, sensitivity)

Below is a pedigree of deafness in which the individuals afflicted by this condition are shown by black circles; normal individuals are indicated in white. Usual symbols for male and female are used. On the basis of the pedigree, answer the following question.



68. The probability for individual #5 to be heterozygous is: a. none at all; b. two chances out of every three; c. two chances out of every four; d. three chances out of every four; e. one hundred per cent.

69. Concerning the old question, "Which came first, the hen or the egg?" select the most appropriate answer listed below.
a. the hen, because there cannot be an egg without a hen;
b. the egg, because direct observation shows there cannot be a hen without an egg; c. the egg, because the first hen probably developed as a result of a series of minor mutations from an earlier bird form; d. the egg, because reptiles lay eggs;
e. the question cannot be answered.

70. The relationship between cells and tissues is similar to: a. the relationship between an enzyme and the substance digested; b. the relationship between organs and systems; c. the relationship between carbohydrates and fats; d. the relationship between ectoderm and entoderm; e. the relationship between the liver and the gall bladder.

71. An unknown food was tested with the following results: a. Iodine--no change in color; b. Nitric acid--no color change; c. Sudan III

--no color change; d. Benedict's solution--color became brick red upon heating. Which one of the following foods would most likely have produced the above results: a. lean beef; b. Irish potato; c. orange juice; d. butter; e. none of the above would do it; the food must have been something not listed.

72. "I have steadily endeavored to keep my mind free so as to give up any hypothesis however much beloved (and I cannot resist from forming one on every subject) as soon as all available facts are shown to be opposed to it." This statement would tend to indicate that its author was a man who: a. lacked convictions; b. had little or no insight; c. exemplified intellectual honesty; d. might be very dogmatic in his views; e. would be easily swayed by propaganda.

73. "When a person speaks of life he has certain concepts in mind. The power of moving about is associated with life, but all living things do not possess this power. Plants are alive and yet many of them do not move about. Crystals grow, hence growth cannot be a characteristic which is restricted to living things. Respiration is considered by some to be the best criterion, but respiration is oxidation or burning, a phenomenon also found in the burning of oil, wood, or coal." The major problem presented in the above paragraph is: a. Do all living things move about? b. Is growth restricted to living things? c. Can any except non-living substances be oxidized? d. Do all people interpret life in the same way? e. What is life?

74. The interior of the lungs of a higher vertebrate is sometimes considered as being exterior to the organism. Such an opinion might reasonably be based on the fact that: a. the content of the lungs is continuous with the external environment; b. in order to reach the blood, oxygen molecules must pass through the cells composing the capillary walls; c. the composition of the contents of the lungs is independent of the metabolism of the cells of the organism; d. simple physical laws are adequate to explain the exchange of gases between blood and lungs; e. the water content of the air in the lungs is the same as that of the air surrounding the animal.

75. Vestigial wings and eyelessness are two recessive characteristics in fruit flies. If a vestigial-winged eyeless fly were to be bred to a pure normal-winged fly with normal eyes, the safest prediction, disregarding environmental factors, regarding the second inbred generation (F_2) from this cross would be that: a. 1/16 of all the individuals from all the broods will be vestigial-winged and eyeless individuals; b. every sixteenth fly would be eyeless and have vestigial wings; c. 1/16 of all the individuals hatched in the first brood would be eyeless and vestigial-winged individuals; d. any of these three predictions, each is equally sound; e. none of these three predictions, none is sound.

APPENDIX D

CALENDAR OF BIOLOGY PRESENTATIONS MADE DURING THE PERIOD OF THIS STUDY AND TEACHER AND STUDENT DAILY SCHEDULES

TEACHER CLASSROOM SCHEDULE

Period	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5	Teacher 6	Intern
1	L. Sci. M 310	L. Sci. L 311	L. Sci. Rotator	Admin.	L. Sci. M 305	L. Sci. M 307	Prep. or Observation
2	L. Sci. M 310	L. Sci. L 311	L. Sci. M 307	Dir. of Sci. 305 A	L. Sci. M 305	Rotator M. W.	Prep. or Observation
3	Bio. B 310	Bio. A 311	Biology Rotator T. F	Instruction and Supervision 305 A	Bio. B 305	Bio. B 307	Consultation and Critique
4	Bio. B 310	Bio. A 311	Biology Rotator T. Lab R. F.	Dir. of Bio. Team 305 A	Bio. B 305	Prep.	Bio. B 307
5	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
6	Prep.	Prep.	Prep.	Admin.	Prep.	M. Sci. M 307	L. Sci. L 305
7	L. Sci. M 310	Athletics Q 2,3, & 4 Lab Q. 1	L. Sci. L 311	Admin.	Athletics Q 1,3, & 4 Lab Q. 2	M. Sci. M 307	L. Sci. M 305

TEACHER ASSIGNMENTS - BIOLOGY

Wk	Subject Matter	Presentor	Lab
1	Introduction and Rules - History and Method	4	
2	Basis of Biology Study: Cell Theory	4	1
	Introduction to Botany	2	1
3	Bacteria	6	3
	Algae	2	3
4	Fungi to Phycomy	2	3
	Phycomy to Lichens	2	3
5	Bryophyta and Pteridophyta	2	3
	Pteriodophyta and Gymnosperms	2	3
6	Angiosperms	3	2
	Roots	3	2
7	Stems	3	2
	Leaves	3	2
8	Flowers	3	2
	Fruits and Seeds	3	2
9	Botany Review	2	3
	Botany Final	Staff	Staff
10	Introduction to Zoology & Protozoa	4	1
	Protozoa, Porifera & Coelenterata	4	1
11	Platyhelminthes Nematodes	4	1
	Mollusca, Annelida	4	1
12	Echinoderm & Arthropoda Crustacea	4	1
	Insecta	4	1
13	Inverts - Review	4	1
	Preverts Through Chondrichthyes	4	1
14	Osteichthyes	4	1
	Amphibia	4	1
15	Reptilia	2	1
	Birds	2	1
16	Mammals	2	1
	Zoology Review	4	Staff
17	Introduction to Physiology	5	6
	Skeleton and Muscles	5	6
18	Food	6	5
	Digestive Physiology	6	5
19	Digestive Physiology	6	5
	Digestive Physiology & Respiration	6	5
20	Respiration & Blood	5	6
	'Hemo The Magnificent' - film		
21	Circulation	5	6
	Circulation	5	6

TEACHER ASSIGNMENTS - BIOLOGY

Wk	Subject Matter	Presentor	Lab
22	Excretory	6	5
	Endocrine	6	5
23	'Gateways to the Mind' - film		
	Sense Organs	6	5
24	Nervous System	5	6
	Exam: Nervous System	Staff	Staff
25	Reproduction	5	6
	Physiology Review	5	
26	Chemistry	4	1
	Chemistry	4	1
27	History of Heredity	1	3
	Mitosis and Meiosis	1	3
28	Gene Theory	1	3
	Gene Theory	1	3
29	Principles of Heredity	1	3
	'Thread of Life' - film	1	3
30	Principles of Heredity	1	3
	History of Embryology	4	3
31	Descriptive Embryology	4	3
	Exper. Embryology	4	3
32	Exper. & Human Embryology	4 & 3	3
	Review	4 & 3	Staff
33	Evolution	5	1
	Evolution	5	1
34	General Review	2	Staff
	General Review	5	Staff
35	Final Exam - Co-op	Staff	Staff
	Final Exam - Wausau Biology	Staff	Staff
36	Ecology	1	3
37	Ecology	1	3
	Exam - Ecology	1	3